The Proposed Harlem River Bridge: Second Prize Plan.

The engraved inset in this edition shows the plan for the proposed new bridge across the Harlem river, near High Bridge at Tenth avenue and 181st street, submitted December 1st, 1885, by Wilhelm Hildenbrand, C. E., to the Harlem Bridge Commission. This plan was prepared in response to a public call for designs and estimates, and was later awarded the second premium of $1,000 by the Commissioners.

According to the specifications issued by the Commission, the piers and approaches were to be of stone, with granite facing, and the superstructure of the main bridge of steel and wrought-iron. The design, complying with the general specifications, was made with further intentions as follows:

First.—To offer to all travelers over the bridge a free and unobstructed view of the surrounding landscape.

Second.—To keep the valley open as much as possible.

Third.—To cross every existing or projected street or avenue at a sufficient height, and in such manner as to necessitate no change in their location.

Fourth.—To harmonize the stone and iron portions so as to make the whole one architectural structure worthy of the site of the proposed bridge.

The first two of the above requirements could only be obtained by adopting for the central part of the bridge two steel arches of proportions dependent on the third requirement. A new street, called River street, has been projected to run along the bulkhead-line on the west bank of the river, while Sedgewick avenue on the east side, about 600 feet from the bulkhead-line, is already located across the axis of the projected bridge. Both of these streets are spanned by arches, the end pier being placed just outside the street lines and the space between divided into two equal spans of 540 feet each.

The clear height of the arches above high water is 135 feet, and 25 feet is the least headroom over any part of a crossed street. The approaches to the main bridge consist of a series of stone arches, each 32 feet span, with two large stone arches over the Boulevard and Boscabel avenue. From these avenues to the termini the approaches are carried on earth filling confined by the retaining walls. The total length of the structure is 2,105 feet, of which the main arches with their abutments occupy 1,180 feet; the avenue bridges, 160 feet; the fillings 390 feet, and the stone viaduct 395 feet.

There is a difference of 23 feet in the level of Tenth and Aqueduct avenues, but the Commissioners propose to diminish this difference by filling up the latter avenue a few feet. The grade of the floor was, therefore, designed to rise slightly from Tenth avenue to the center of the bridge, then to fall with the same inclination to the end of the arch and from there with an average grade of 3 per cent. to Aqueduct avenue.

It is intended to construct the arches with three hinges, thus insuring certainty in the calculation of the stresses; and also, in the present case, making a more economical structure than on unhinged arch, as the extra strains due to temperature are avoided, and those produced by unequal loading are comparatively small on account of the immense dead weight of the floor system.

There are five arches or ribs in the entire width of the bridge, which is 80 feet. The height of one rib in its center is 16 feet, increasing towards the abutments to 18½ feet. On these ribs lattice columns are placed 16 feet apart, which support the main floor beams. These floor beams have a height of 42 inches and support a series of longitudinal girders 20 inches high located 10 feet apart; on these girders are placed 9-inch I beams, 2½ feet apart, which support a floor of corrugated iron to be finally covered with concrete and Belgian pavement for the roadway and marble tiles for the sidewalks.

Each chord of a main rib contains 80 to 90 square inches of steel. The chords will be box-shaped, composed of channels and plates and the total quantity of steel and iron in the two arches amounts to about 4,800 tons. The total quantity of masonry in piers and approaches is about 100,000 cubic yards. The estimated cost is $2,250,000.

Drainage District and the Construction of Drainage Canals*.

A. H. BELL, CITY ENGINEER, BLOOMINGTON, ILLINOIS.

The most extensive drainage district of this State, to my knowledge, is that of Mason and Tazwell counties, embracing about 50,000 acres of land. The work was contracted in 1884 to W. A. McGillis & Co., at fifteen cents per cubic yard. They at once put in three dredges, manufactured at Bucyrus, Ohio, and have continued to work them ever since, with little intermission. Two others have since been added of a smaller type and somewhat different style, but I think are not so successful in their operations. This firm has tried the same machine, placed on wheels, to work on the banks, without success at last accounts. I know of no dredge or other machine for ditching purposes that will give sufficient depth excepting those operating on boats. The general method of operating is to work down the stream, though it is possible to work either way by the use of dams, provided the fall be not too great.

Most of the ditches of the Mason and Tazwell district are from 8 to 10 feet deep, having a fall or grade of from 2 to 3 feet per mile. The main ditch, which is now nearly completed, is 15 miles long, running from 35 to 60 feet top width with a slope of 1 to 1 for the sides. There are 5 principal laterals to this main ditch, averaging 30 feet on top and from 8 to 10 feet deep. I have not visited this district for some time, but believe this entire contract is now very near completion. The entire work has cost somewhat over $300,000. Assessments on land will range from $2.50 to $10 per acre.

The most sanguine hopes of the property owners have been realized in the results achieved by this undertaking. Thus a district which heretofore was a paradise for the wild goose and the curlew, and where the eccentric heron poised upon a solitary pedestal to watch the frolic of the frogs, is brought into the market and ranks with the best in the land the state can produce for agricultural pursuits.

I am informed that another very large district is now organized south of the Mason and Tazwell District and will furnish a large amount of work for dredge boat excavation.

The Lake Fork Special Drainage District of Piatt county is cutting a ditch about 14 miles long, 35 feet top width and from 7 to 9 feet deep. This contract is being executed by Pollard, Goff & Co., with headquarters at Bement. They now have about 7 miles of the ditch completed. The benefits already derived are very perceptible, and the land owners are much elated over the prospective results.

The dredge used is of the same design as that in the Mason and Tazwell District. 1,200 cubic yards a day of 24 hours is about an average day's work for one of these machines. It requires 5 men to each day and night shift, besides sufficient help to cook and manage the cabin boat which follows in the rear of the dredge.

The depth that can be obtained and the rapidity with which work can be executed are the strong features commending the use of dredge boats for ditching purposes. Experience in this branch of the profession will soon convince the most skeptical engineer that depth is the great desideratum to be obtained for an open ditch, where any considerable amount of subdrainage is desired. While an open ditch of a very few feet depth may relieve a district of overflow at times, it will never furnish underground drainage sufficient for any practical use. It is not so much the water that lays upon the surface of land that renders it unavailable, but the humidity of the soil itself. The effect of a deep ditch is similar to that of tile, to give constant sub-drainage, thereby rendering land porous and susceptible of a great degree of absorption. The value of swamp or wet land that has been properly drained has been already demonstrated in many instances in this State.

The North Quiver Swamp in Mason county is the most striking demonstration of this kind to my knowledge. This tract of land, about 5 miles in length and from 2 to 3 miles in width, ranged northeast and southwest, and was one of the most impregnable swamps I have yet had to contend with in my experience of drainage engineering. It was mostly grown up with bullrushes and other rank vegetation, the water being in many instances 3 or 4 feet deep. Fish abounded in numbers, having myself seen pickerel taken out of the swamps measuring 26 inches in length; ducks reared their young, and muskrats and mink reigned supreme. For the space of a mile along the middle of this swamp there was no perceptible current; from either end of the mile the water flowed but slowly, northeast into the Mackinaw in the one instance, and southwest to the Illinois river in the other, thus making a divide in the grade which was adhered to in the final construction of a ditch, that most effectually drained every portion of the swamp.

The canal here constructed was 30 feet top width and 15 feet bottom, ranging from 7 to 9 feet deep. This land is now all available to the banks of the ditch, and I have seen growing upon it some of the best corn the State has ever produced.

*Abstract of a paper read before the Illinois Association of Engineers, Champaign, February 10-12, 1886.

Death-rates Among College Graduates.

The recent death of Charles W. Sanborn of New Hampshire, is the occasion for calling attention to a remarkable fact.

His death is the first that has occurred in the Dartmouth college class of 1872. Sixty-nine men graduated, and for thirteen and one-half years their number has continued unbroken by death. The Chandler scientific class of the same year early lost one man from eleven who graduated.

The deaths in the two preceeding and nine succeeding classes to 1872 are recorded as follows;—

Class.	No. graduated.	Deaths since graduation.
1870	50	11
1871	68	9
1873	71	4
1874	68	5
1875	48	1
1876	69	4
1877	54	2
1878	74	3
1879	46	3
1880	48*	1
1881	49	3

*One died just before commencement, and received degree *post obit.*, but is not included here.

EDWIN J. BARTLETT.

—*Science*, January 28th.

Municipal Engineering; Paper No. 1.*

BOSTON, MASSACHUSETTS.

(*Continued from page 103.*)

Gates and Hydrants.† There are 3,932 gates in the Boston distribution, or about one for each 500 feet of pipe. These now used under 20-inch are made in the department shops Plates 10, 11 and 12 ** show respectively the 6-inch, 8-inch and 36-inch gates of adopted patterns. The 36-inch gate is peculiar in so much as it lies on its side instead of being placed vertically as usual, the dead weight of the gate being carried on a pair of rollers as shown.

Hydrants. The hydrants set prior to 1868 are of the pattern shown in Fig. 7, Plate 13*a*, 3½ feet below the street surface, required constant attention to prevent them from being frozen. These hydrants are now being gradually replaced by others of larger capacity, but about 1,500 of them are still in use.

After the annexation of Roxbury in 1868, the Lowry hydrant, Fig. 3, Plate 13 and Fig. 5, Plate 13*a*, was introduced. This hydrant has a 9-inch barrel and is placed directly over the distribution main, and in many cases at the intersection of mains, so that it may furnish a large amount of water. A portable casting called a "chuck" (Fig. 3, Plate 13) can be screwed into the head of the hydrant and supply four steam fire engines at one time with water. Difficulty was experienced in opening the valve in this hydrant owing to its large area, and a pattern with a smaller valve opening upward (Fig. 4, Plate 13*a*) is now used, has a 6-inch barrel similar to the Post hydrant and a top adopted to receive the Lowry "chuck;" both of these hydrants are connected to the street-main by 6-inch pipes.

Both hydrants and gates are enclosed in wooden boxes of a sufficient size to be entered for purposes of repairs. The general form and construction of these boxes is shown in Figs. 4, 5, 7 and 8, Plate 14. For the past ten years they have been made of kyanized spruce lumber, and their average life, since 1850, is about 15 years. The cost of the box with its iron frame and cover is only about $8; and the cover is sometimes made with the studs and lettering alike on both sides so that it can be reversed when one side is worn smooth, the slight additional cost of the extra iron required is more than compensated for by the much increased service.

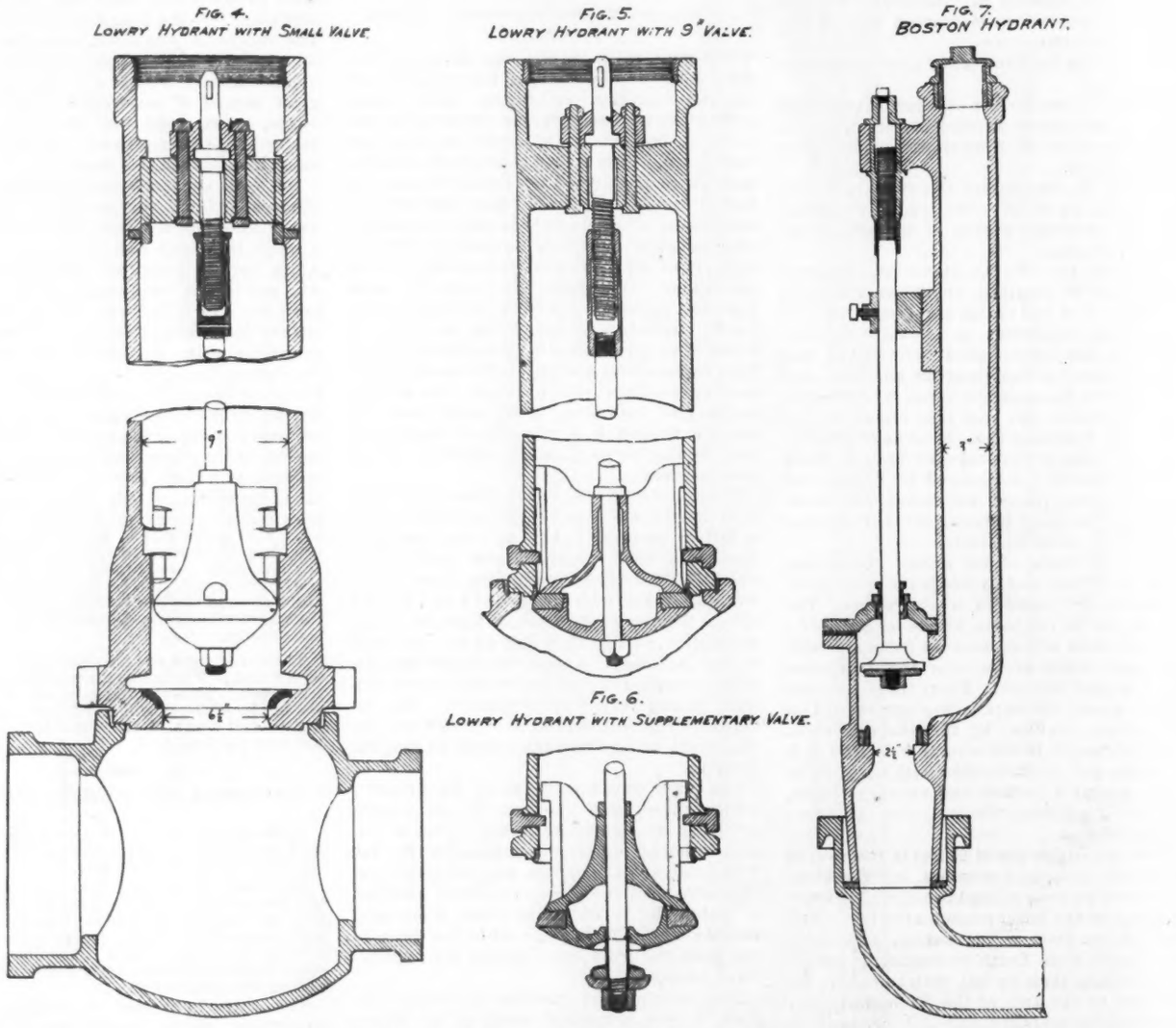


Plate 13a.—Lowry and Boston Hydrants.

had barrels only 3-inches in diameter and were supplied by a 4-inch branch-pipe from the main. Many of these hydrants had been in use from 25 to 35 years and their original small capacity has been greatly reduced by tuberculation. Their valves, too, being only and the original large valves have been fitted with a small supplementary valve which being first opened relieves the pressure on the main valve (Fig. 6, Plate 13*a*). As this hydrant is located in the roadway its cost of maintenance is large, and, except when it is deemed expedient to mass a number of engines, a smaller sidewalk hydrant is preferred. Of the latter there are now two patterns in use; the Post hydrant (Figs. 1 and 2, Plate 13) has a 6-inch barrel and is used in the outlying districts and where the pavements are wide enough to permit its use without annoying the public. The other hydrant, not illustrated,

The stranger in Boston has doubtless often been puzzled as to the intent and meaning of the letters G, H and R, with certain cabalistic addenda, which stare at him from lamp-posts, sides of houses and other exposed surfaces. Plate 14 *a* shows a stone post near the Old South Church so decorated. These signs are put up by and intended for the use of the fire department and indicate the location of gates, hydrants and water reservoirs; and with hydrants which do not appear above the surface of the streets or sidewalks, such guides are extremely useful and even necessary during the winter season.

*Copyrighted by the Engineering News Publishing Co., 1886.

†The descriptive matter and some of the plates immediately following are taken from a paper read by Dexter Brackett, C. E., before the Boston Society of Engineers on May 20, 1885, and published in the February number of the Journal of the Association of Engineering Societies.

** Not to overcrowd the cuts in this issue, Plates 10, 11 and 12 will be given next week.—ED. ENG. NEWS.

To describe those illustrated, "G" signifies that there is a "gate" 8 feet from the post and in the direction indicated by the arrow. The "H" means a hydrant, and the small letter in the upper part of the H shows that it is either a Lowry or a Boston hydrant; another hydrant sign not shown here has a P in it, meaning "Post" hydrant. The figures below each hydrant symbol show the distance to that particular hydrant.

The "R" indicates an old brick "reservoir" below the pavement, put in years ago to equalize the fire supply of water. They are now out of date, but are still preserved, and the fire department pays $20 per annum for each one of them. These reservoirs hold from 300 to 400 "hogsheads" of water and date from a period prior to the introduction of the present distribution system. They are now

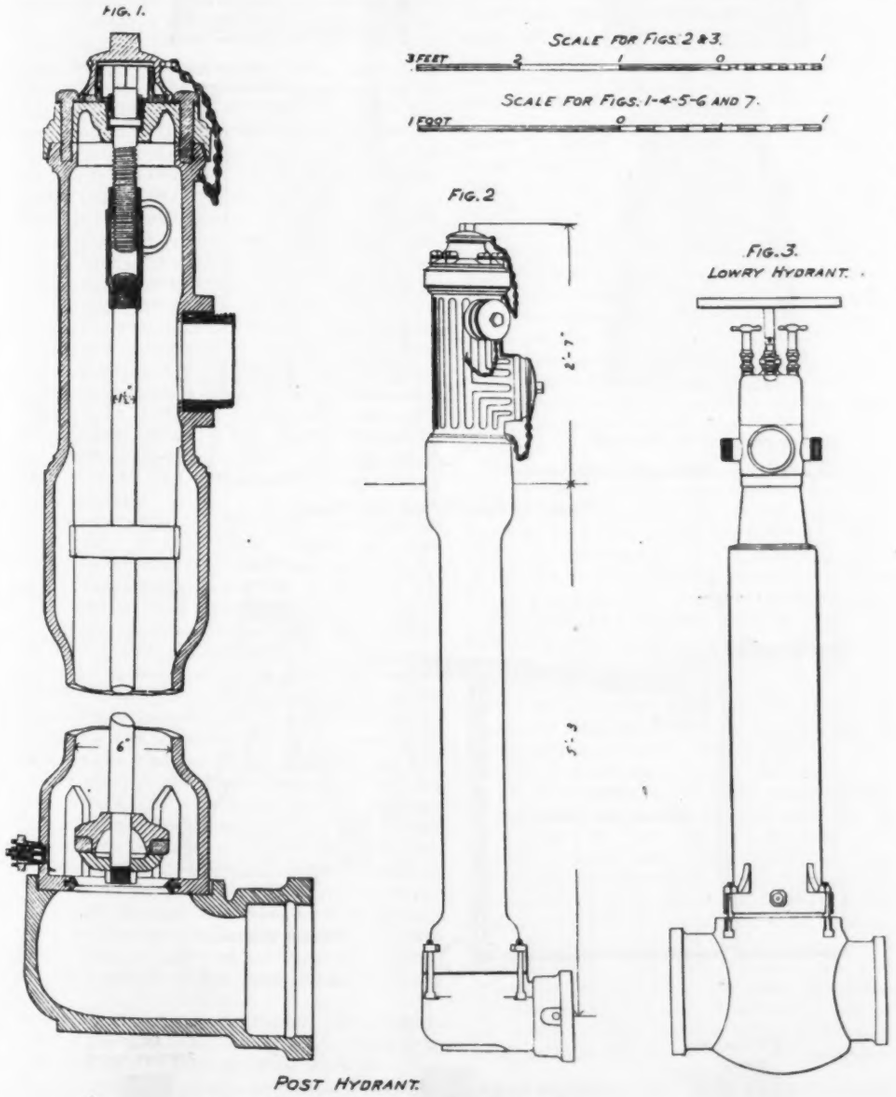


Plate 13—Lowry and Post Hydrants.

connected with the water mains by branch pipes fitted with gates.

The Church Stop-Cock. From 1848 until 1879 the only stop-cock for shutting off water from the buildings was the one inserted directly in the main and reached by an iron tube whose top was 6 to 12 inches below the street surface and covered by a loose cap (Fig. 1, Plate 15). This was intended to prevent the operation of the stop-cock by unauthorized persons, but it resulted in trouble during cold weather, or on concreted streets. For the past five years an additional stop-cock has been placed in the sidewalks and made accessible by a telescopic tube.

A new form of stop-cock to be used in place of the ordinary form of sidewalk stop-cock has lately been adopted by the Water Board. Three hundred of these are now in use, and it is intended to place them on all of the services throughout the city, 9,000 being ordered by the Water Board. This stop-cock, shown on Plate 15, Figs. 2 to 8, is known as the Church stop-cock or waste detector*, as in addition to the usual functions of a stop-cock it can be used to detect and determine the amount of water which may be wasting from a service-pipe to which it is applied. In addition to the usual water passage, there is in this stop-cock a small supplementary passage, *A*, through the plug, which, by means of the tube, *B*, can be connected with a pressure gauge attached to the top of the tube. When the plug of the stop-cock is turned to a certain position, the water passes from the street main through the small orifice *A* to the gauge and indicates the water pressure in the main. Now, if the plug is turned to the position, shown in Figs. 5 and 6, water will pass through the small orifice into the house, and if there is any leakage taking place from the house fixtures, the pressure on the gauge will at once fall; the amount of the loss of pressure being dependent on the quantity wasting. A third position of the cock connects the gauge with the house service, closing the connection with the street main, and if the leak in the house be at a point 23 feet above the gauge, the pressure will fall to 10 pounds and there remain, showing the height above the gauge that the leak may be found.

Very small leaks can be detected, a loss of pressure of one pound indicating a waste of 15 gallons per hour. In detecting waste by means of these stop-cocks an examination of all the service-pipes in any street is made in the manner just described, between the hours of midnight and 4 A. M., when all legitimate use of water is supposed to have ceased, and the premises where waste is noted are examined on the following day, and the causes of waste discovered and remedied.

*This stop-cock is the invention of Benjamin S. Church, C. E., now Chief Engineer of the New Croton Aqueduct.

Improved Sewerage

As noted among the duties of the City Engineer, that official has charge of the construction of the new intercepting and outlet sewers of the city of Boston, and we follow with a short sketch of the system and the causes which made it necessary. The material here used is in great part taken from the excellent history† of this work published by Mr. Eliot C. Clarke, C. E., the Engineer-in-Charge of its construction, and to this work we must refer our readers for further detail.

The original drainage of Boston was the result of individual effort on the part of the property owners, and drains were built without any official or engineering supervision as to design, material or dimensions, far into the present century. When Boston became a city, in 1822, one of the first acts of the new government was to assume control of the existing sewers and the building of new ones, but the whole expense of so doing was, as before, charged to the estates benefited. The city ordinances provided that they should be, when practicable, large enough to be entered for cleaning, and some slight supervision was exercised over their connection with house drains. Until 1833, all fecal matter was rigidly excluded, and in the year named fluids from vaults only were admitted.

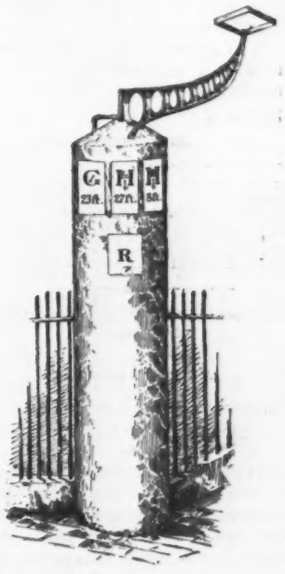


Plate 14a—. Fire Department Signs.

In 1837 a Superintendent of Sewers and Drains was appointed, who was to give his whole time to the financial and administra-

†"Main Drainage Works of the City of Boston, Mass.," by Eliot C. Clarke, Engineer-in-Charge, Boston, 1885.

tive duties connected with the sewerage. In 1838 the City decided to assume one-quarter of the gross cost of construction, and in 1840, in obedience to a decision of the Supreme Court, it was ordered that the three-quarters of the cost of the sewers which was to be paid by abuttors should be assessed with reference to the value of the land alone, without regard to the value of the buildings or other improvements upon it. This ruling has continued in force to the present time.

In 1869, it was estimated that there were 100 miles of sewers in Boston; in 1873, there were about 125 miles. In 1857 there were only 6,500 water-closets in the city, while in 1885 there are over 100,000.

The defects of the old sewerage, aside from original faulty design and construction, have been much aggravated by the radical change in the surface and increase in area of the city. As already noted, Boston proper covers nearly three times as much ground as it did a century or less ago; instead of its former undulating and easily drained surface, its hills have been cut down and a vast amount of new territory added by filling in old water ways to a level, but little above that of mean high tide. Old drains, with but slight original fall, have been extended through this filled ground to the new water front, with the result that their outlets were little if any above low water mark. As the rise of tide is about 10 feet, each of these outlets was dammed back by the rising tide for 12 hours in each 24, and the tide gates provided to keep out the salt water shut back the sewage, allowing it to accumulate in the sewer, deposit its solids and saturate any loose soil in its neighborhood through the leaky wooden boxes very generally used.

TO BE CONTINUED.

NOTE.—On page 83 of Boston Municipal Engineering in speaking of the standard dimension of cast-iron pipe, the weight of iron is given at ".2064 pounds per cubic inch." This is a misprint. it should be .2604 pounds per cubic inch. On page 84, the cost of gates, hydrants, etc., should be 15 cents *per lineal foot of pipe*; not, "per pound" as given.—ED. ENG. NEWS.

The Physical Theory of the Steam Engine and Boiler.

A POPULAR STATEMENT.

Written for ENGINEERING NEWS.

BY ALFRED R. WOLFF, M. E.

The physical theory of the steam engine and boiler, like that of any other branch of engineering and natural science, rests fundamentally upon the great principle of the conservation of energy. It is not necessary for our purposes to enter into a detailed analysis of what is meant by conservation of energy, and we may accept as a satisfactory expression of its law, that the amount of energy in the material universe is ever a fixed quantity. It follows from this, necessarily, that what is termed expenditure is, in fact, but a change of form of energy. There can be no "waste" of energy in the material universe, in the absolute sense of the term though in the attempt or process to attain a particular effect, much of the energy expended may prove to be a waste so far as the result desired is concerned.

The whole physical theory of the steam engine and boiler resolves itself, then, into a consideration of the changes undergone by the energy present (but latent) in the fuel, until it is given out (in part) by the engine shaft as useful work, either in driving machinery, propelling vessels or overcoming other similar external resistances. We will find in the course of our analysis that a great—by far the greater—part of the energy latent in the fuel will be lost (or a waste) as far as the useful work available at the engine shaft is concerned. Indeed, we may as well premise as a matter of interest, that necessarily about 81%, usually a still greater proportion of the energy in the fuel, much to the engineer's regret, will go to increase the temperature of the surrounding atmosphere, and that with the best conceivable forms of steam engines and boilers only 19% of the energy of the fuel can theoretically demonstrate itself as useful, available power at the engine shaft, while practically only 10% is realized in useful work.

We may also premise that this low efficiency of 19% is not due to faults of mechanical construction of the engine and boiler, nor to losses of friction in transmitting motion, but

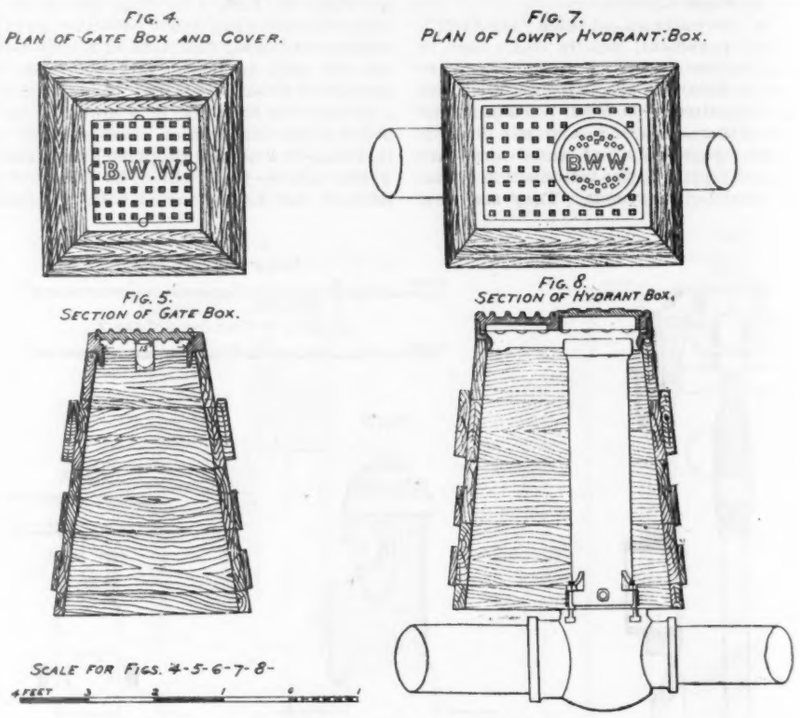
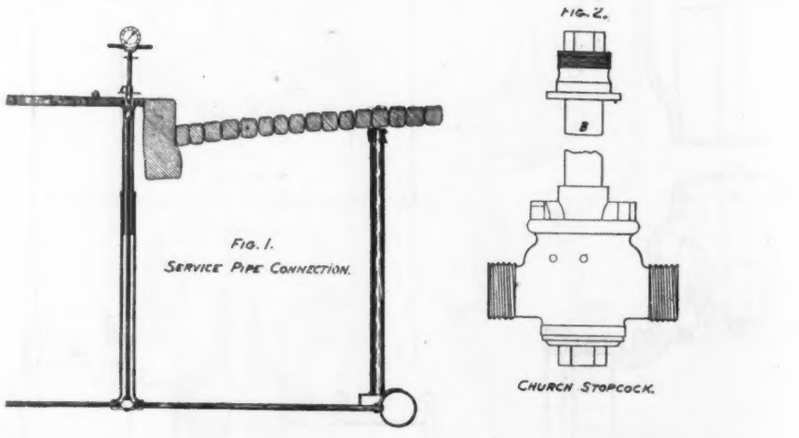


Plate 14.—Hydrant and Gate Boxes.



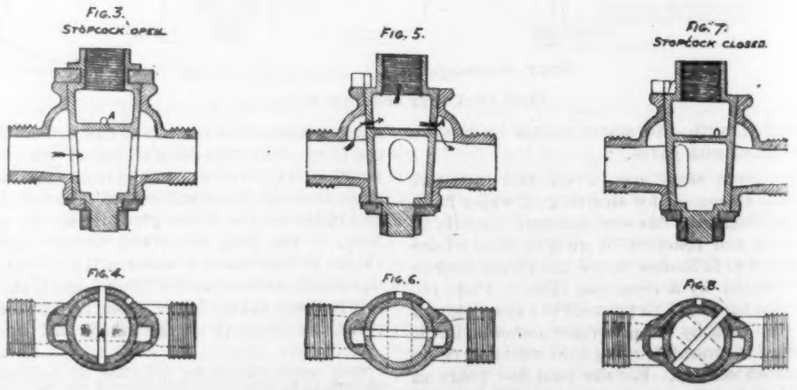


Plate 15.—Church Stop-cock.

results from facts conditioned by physical law, and therefore in their very nature unalterable and commanding.

And yet, despite the great loss which is coupled with the employment of steam engines as converters of heat into mechanical energy, they still, and rightfully too, constitute the leading prime-movers in the world, and at the present outlook are destined to do so for some time to come, both in regard to the number in use, and especially in the horse-power equivalent of work their united efforts represent.

The function of the steam boiler is the conversion of the heat energy resident in the fuel into the heat energy resident in the steam. Accordingly, it consists of a furnace and combustion chamber, in which the combustible portion of the fuel is united with the oxygen of the air, and of flues and tubes for carrying off the heated products of combustion, the heat of the furnace proper and of the gases in their transit through the flues and tubes being conveyed to the water in the shell of the boiler. The metal of the shell and of the tubes being comparatively thin, and the temperature of the fire and of the products of combustion being largely in excess of that of the water and steam in the boiler—the difference ranging from some 2,000° Fahr., at the furnace to some 75° Fahr. at the point where the gases enter the chimney—,the conduction of the heat of the burning fuel and of the escaping gases to the water and the steam is very rapid—practically instantaneous. It is found, however, that in order to insure proper conduction at the point where the gases leave the boiler, the temperature of the escaping gases must exceed that of the steam and water in the boiler by, at least, 75° Fahr., and in ordinary practice the gases frequently enter and leave the chimney far in excess of the 400° Fahr. temperature which this excess of 75° implies.

The water is fed into the boiler at a temperature say of 165° Fahr. heated to this temperature from that of the atmosphere, by the exhaust steam from the engine, or by other means. The heat conveyed to the water first raises its temperature from that of feed to that of boiling point under the given pressure, and then converts the water into steam. The function of the chimney is to carry off the gases where they will not be annoying or destructive, and to cause the draft; that is, to draw in the amount of air required for the combustion of the fuel. The difference between the weight of a column of the external air at atmospheric temperature, and of the column of the lighter heated gases in the chimney, acts as the propelling force from without to push the atmospheric air below the grate, through the heavy mass of burning fuel, into the combustion chamber, and thence in the form of gaseous products of combustion through the tubes, flues and the chimney itself.

Having thus briefly indicated the mechanism of the steam boiler, we may proceed to analyze its efficiency as a heat machine.

A pound of carbon in its complete combustion to carbonic acid, that is, in its union with the weight of oxygen contained in 12 pounds of air, produces, or liberates an amount of heat equal to 14,500 British thermal units. In other words, were all the heat given out by this combustion centered on, and entirely conveyed to, 14,500 pounds of water at 39° Fahr. it would raise the temperature of this amount of water one degree. Or remembering that all the energy exerted in the fall of 772 pounds a distance of one foot, or 772 foot pounds of energy, is just sufficient to raise the temperature of one pound of water at 39° Fahrenheit one degree, the heat energy given out by the complete combustion of one pound of carbon will equal $772 \times 14,500 = 11,194,000$ foot pounds or the work expended in raising 11,194,000 pounds one foot, or 11,194 pounds 1,000 feet.

Ordinary anthracite coal contains about 5% of oxygen and hydrogen, combined in the shape of water so that no heat is derived from the hydrogen. The earthy matter, silicates, etc., average about say 12%. Altogether an allowance of $\frac{1}{6}$ is about the correct deduction for the earthy and other non-heat-giving bodies in the coal, so that the total heat energy developed by the combustion of a pound of coal equals some $\frac{11,194,000 \times 5}{6} =$ 9,328,000 foot-pounds

It is evident that all the heat energy developed in the furnace by the combustion of the carbon of the pound of coal is communicated tothe water and steam in the shell, except 1st., such heat as escapes by external conduction and radiation through the ash-pit, furnace-walls, and from the boiler front, and 2d., such heat as goes off in the escaping gases of the chimney. The boiler is either securely enclosed by heavy non-conducting brick-walls, or if it is internally fired (the furnace in that case being in a flue within the shell of the boiler),it is covered in all the parts exposed to the atmosphere by non-conducting hair-felt and other covering so that the loss by external radiation may be declared to be very small,and we venture to assert that in first-class practice it does not materially exceed an average of one per cent. of the heat energy developed in the furnace. The principal loss is therefore that measured by the heat energy contained in the gases as they leave the chimney, and the loss from this source may be readily determined.

Let us assume the steam pressure in the boiler to be 100 pounds per square inch (absolute) or that the temperature of the steam and water in the boiler will be approximately 325° Fahr.; the temperature of the escaping gases as they enter the chimney should then not be more, nor may it, for proper conduction of heat of gases to steam and water in shell, be less than 400° Fahr., or say 350° Fahr., in excess of external atmosphere and of the air entering the furnace. For every pound of carbon burned, at least 12 pounds of air will be required, so that the least weight of gases produced must be 13 pounds. The specific heat of these gases is .237, that is to say, to raise one pound of these gases one degree of temperature will demand only .237 of the amount of heat required to raise one pound of water one degree Fahr., so that 350 degrees of temperature of these gases will correspond to $350 \times .237 = 82.95$ thermal units, and 13 pounds each containing 82.95 thermal units will contain altogether $82.95 \times 13 = 1078.3$ thermal units. This will represent the loss of heat by the escape of the gases from the chimney for every pound of carbon burned, or for every 14,500 thermal units developed. The loss from this source under the conditions stated will then equal $\frac{1078.3 \times 100}{14,500} =$ not quite 7.5 per cent. of the total heat energy developed by the fuel.

The loss from this source practically, however, is found to be much greater and is due to two causes.

1. That the temperature of the escaping gases is frequently greater than 400° Fahr.

2. That the quantity of air drawn into the furnace is double the amount needed for complete combustion.

The first loss good practice condemns, and since in many boilers the temperature of the escaping gases does not materially exceed 400° Fahr., we may disregard this source of waste in the present discussion.

The average of good boiler practice will show that at least double the weight of air absolutely needed for combustion is supplied to the furnace. This is ascertained by volumetric measurement and is also made evident by the temperature of the fire. A pound of carbon giving out 14,500 heat units by its complete combustion, the mean specific heat of the 13 pounds of products of combustion being .237, the temperature of the furnace, if only 12 pounds of air were supplied for each pound of carbon burned, would be $\frac{14,500}{13 \times .23} = 4580°$ Fahr. But if diluted with air equal to a quantity needed for complete combustion, the heated gases will equal 25 pounds for each pound of carbon burned, and the temperature of the furnace will be $\frac{14,500}{25 \times .237} = 2,440°$, agreeing with the figures found in practice by pyrometrical measurement.

It results, then, that for each pound of carbon burned 25 pounds of gases, at temperature of 350° Fahr. above that of the atmosphere will leave the chimney,and the thermal loss will equal, instead of the 7.5 above mentioned, $\frac{350 \times .237 \times 25}{14,500} = 14.5$ %. Adding to this a loss of one per cent. for conduction and radiation through furnace walls, and boiler shell to external atmosphere, we obtain as the efficiency of the boiler 84.5 %. This result is not unfrequently recorded in experimental trials when the boilers are new and kept in first class condition, while 80 % is by no means an unusual figure in the best working practice. 80 % of the heat of combustion then demonstrates itself in the rise of temperature of the water in the shell of the boiler and in its evaporation into steam.

The process of the formation of steam within the boiler consists of two parts, the act of supplying 160 British thermal units to each pound of water to raise its temperature from that of feed, say 165° to the temperature of evaporation, say 325° (this corresponds to a pressure of steam of 100 pounds), and then supplying some 880 extra thermal units, to change each pound of water at 325° Fahr., into steam of the same temperature. The 880 extra thermal units, known as the latent heat of steam, go for the expenditure of that tremendous amount of internal work involved in the striking molecular change noted between water and steam. Thus we see that some $160 + 880 = 1,040$ thermal units are needed to change each pound of water fed into the boiler, into steam of 100 pounds pressure, and were all the heat of combustion of our pound of carbon utilized effectively in this process, without any loss whatever, the pound of carbon would evaporate $\frac{14,500}{1,040}$ say 14 pounds of water into steam, under the conditions named. Only, however, 80 % being available, the evaporation falls to $14 \times .8 = 11.2$ pounds of water per pound of carbon, which accords with the record of experimental tests of the performance of boilers.

This briefly explains the physical theory of the steam boiler. It only remains to be added that a portion of the waste of the chimney gases is occasionally recovered by providing that the gases after they leave the boiler heat the air supplied to the furnace. However, these and similar expedients practically only enable a small percentage of saving of the heat of the gases. Still we may conceive that by like methods, the boiler efficiency may be raised to 90 %, and we adopt that figure as the

best which the physical theory of the boiler admits of.

We started out by saying that, by the very condition of physical law, the steam engine and boiler combined could, in their most perfect forms conceivable, only realize 19 % of the heat energy in the fuel, and still we have seen that an efficiency of 90 % is theoretically attainable in the boiler. It would follow then, if our original statement be correct, that the great squanderer of heat is the steam engine itself and that the efficiency of the most perfect steam engine conceivable cannot exceed 21 per cent. To make this clear will necessitate some explanation of the fundamental laws of thermodynamics. We shall first, however, following the same plan of the boiler discussion, give just a brief account of the mechanism of the steam engine.

The steam is led from the boiler by means of a large pipe to a receptacle at the top or side of the cylinder of the engine, such a receptacle being known as the valve chest. This valve chest contains the valves or metal pieces which slide over ports or openings leading to the cylinder. The valves are operated from moving parts of the engine and are so arranged and their motion so regulated that while the steam enters from the valve chest through one port to one side of the piston, moving the piston forward, the other port is open to the atmosphere, or to the condenser, so that the steam on the other side of the piston escapes to the atmosphere or to the condenser. By piston is meant the disc in the cylinder on which the steam exerts its pressure and which it moves. After the piston has moved a portion of the entire length of the cylinder, or has made a fraction of its stroke, the valve admitting steam into the cylinder has, in its motion, reached such a position as to no longer admit steam into the cylinder, and the steam then present in the cylinder continues to propel the piston forward, but of course falls correspondingly in pressure. By the time the forward stroke of the piston is completed, the position of the valves has so changed that steam of initial pressure is admitted by the second port to the reverse side of the piston, and the front end of the cylinder is open to the atmosphere or to the condenser. The result is that the steam on the forward side of the piston escapes into the atmosphere or into the condenser, and the steam on the rear side forces the piston to complete the return stroke, when at the end of the return stroke the valves are again in their initial position, and the forward stroke again begins.

Constant reciprocating motion of the piston thus ensues. This is converted into rotary motion by a connecting rod and crank and shaft, and the power is stored, steadied and regulated by a large wheel on the shaft known as the fly-wheel. When the steam, after leaving the cylinder, exhausts into the atmosphere, the engine is known as a non-condensing engine (sometimes erroneously called high pressure engine), and when the steam enters a condenser or a vessel in which it gives off its latent heat to water circulating in tubes, and is changed to water—which condensed water is then fed into the boiler—, the engine is known as a condensing engine, sometimes erroneously called low pressure engine. A compound engine is one in which the expansion of the steam takes place successively in two or more cylinders, instead of one cylinder. Having thus briefly indicated the method of operation of the steam engine, we may proceed to discuss its theory and efficiency as a heat machine.

The function of the steam engine is the conversion of the molecular motion of heat (of the steam) into the sensible motion of the heavy moving masses of the engine, the piston, fly-wheel, etc., which latter being weight in motion represent energy available for external work. An engine in the physical sense, is, then, simply a device for lowering the heat energy resident in the steam, the difference of the heat in the steam in its initial state, and in the final state when it leaves the engine, being transformed into mechanical work. The expansive property of the steam, by virtue of which it exerts pressure, is the means used for effecting this lowering of heat (or change of heat into mechanical energy); for the exertion of pressure against a resisting mass, which mass is set in motion, requires the expenditure of energy. This is derived from the heat energy initially in the steam. The effect is that the molecular rotations and translations of the particles of steam, which are synonymous with the term "heat" decrease in velocity, and the temperature (also the pressure) of the steam is lowered by an amount equivalent in heat energy to the energy expanded in mechanical work. It is very important in a correct understanding of the physical theory of the steam engine to bear in mind that the propelling or expanding fluid (steam) simply represents a medium for the lowering of the heat energy resident in the fluid, and for the conversion of such heat energy into the mechanical energy represented by the moving parts of the machinery. This brings us to a consideration of the first law of thermodynamics, to which we have already referred in our discussion of the boiler question, though we did not there mention it by name.

TO BE CONTINUED.

The Greathead Injector Hydrant for Fire Extinction.

As the Greathead system of increasing pressure on hydrant streams from existing water supplies in great cities has been lately proposed for New York, but seems to be little understood, we give the following account of the system as practiced in Hull and London:

In a paper lately read by Mr. J. H. Greathead before the Mechanical Science Section of the British Association, at Southport, the author points out the fallacy of continually maintaining upon a distribution service a pressure sufficient also for fire extinction, and he then describes the system he proposes as an economical and efficient substitute.

His proposition is to utilize any existing water supply for volume required, but to supplement insufficient pressure by applying power obtained from a separate system of small mains conveying water under a pressure of from 800 to 1,000 lbs. per square inch. This power is applied to a hydrant stream through the medium of the well-known accumulator system for hydraulic power introduced years ago by Sir William Armstrong, and by an injector hydrant connected with the street hydrant. The fire stream would be delivered directly from the hydrant without the intervention of a fire engine, and the stream delivered would have a pressure proportioned to the relative volumes from the two pipe systems and the initial pressures on the two supplies.

The injector hydrant (see illustration) is based upon the principle of the "lateral inductive action of fluids" as utilized by Giffard in his injector and in various other ways. In the diagram, Figs. 1 and 2 show sections of a double hydrant on an 8-inch main. A is the branch for supplying water from the ordinary city system, and this branch may be long or short as the conditions would require; B is an ordinary screw-down valve closing the branch *A*; the branch *C*, from a small hydraulic power pipe, bending upwards terminates in the nozzle and is directed into the ascending limb *D* of the hydrant, and beyond this nozzle are two trumpet-shaped guide tubes I, held in the iron casing *D*. The hose attachment is made at *E*.

The inventor says that the quantity of power water required to produce any desired jet will depend on the pressures in the ordinary water service. To produce an inch jet of 150 gallons per minute, with a low pressure of 30 pounds, the quantity of power water required would be 25 gallons for each 150 gallon one-inch jet; and for 14 such jets it would be 353 gallons per minute. Assuming that 14 jets on a single line of pipe were required at one time—an improbable condition—, and that the point of discharge was distant half a mile from each of only two accumulator stations, this quantity of water could be sent through a 3½-inch pipe with a loss of only 12 per cent. of the power by friction.

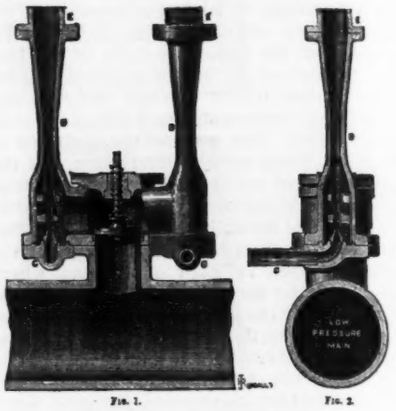


Fig. 1. Fig. 2.

THE GREATHEAD INJECTOR HYDRANT.

The actual size of the power pipes would be determined, however, by the extent of the district assigned to each engine furnishing the power. Mr. Greathead claims, that, as the pressure in the ordinary main is fully utilized, with 25 pounds pressure in the mains the resultant efficiency of the hydrants with the injector attachment would be double that of a fire engine. As to cost, he estimates that the entire metropolis of London could be protected by an efficient system of injector hydrants for £1,500,000, or say, $7,500,000, including pipes, hydrants, engines, pumps, accumulators, etc. The working expenses at the outside would not exceed $15,000 per annum; and with interest at 3½ per cent. the annual cost would not exceed £55,500, or $277,500.

Mr. Greathead furnishes the following table of high pressure, or power water, required for various heads of low-pressure water to supply the jet described:—

Low Pressure Supply.		High Pressure at 700 lbs. per Sq. Inch.
Lb. per sq. inch.	Feet head.	Gallons per minute.
60	138	3.7
50	115	10.9
40	92	18.1
30	69	25.2
20	46	32.4
10	23	39.6

The above table is founded on the results of experiments with from 10 to 20 pounds pressure per square inch of low-pressure supply. The high pressure is taken at 700 pounds per square inch. The quantity given is for a jet of 150 gallons per minute delivered from a one-inch nozzle, variously estimated to ascend to a height of from 75 to 84 feet, and requiring a pressure of 100 feet head at the back of the nozzle. The length of hose is taken at 200 feet of 2½-inch "brigade" hose, the resistance of

which for that discharge is taken at 3 inches of head per foot of hose.

In answer to an objection raised by Mr. Baldwin Latham, that the hose would probably burst under the undue pressure if it was permitted to kink, Mr. Greathead says that under such conditions the hose would probably burst, but that in any case a valve was so placed as to prevent any back pressure upon the ordinary water mains.

The advantages of this augmentation of power or pressure simply, as contrasted with an increase of total water supply to meet a fire demand, become apparent, when we compare the relative volumes of water required for domestic consumption with that actually used up annually in the extinction of fires. The *daily* water supply of London is 150,000,000 gallons, while the total quantity used in 1882 for fire purposes was 17,000,000 gallons for the whole *year*. In New York, the figures stand at about 110,000,000 gallons daily for general consumption, and 53,000,000 gallons for the annual fire consumption.

As to the feasibility of subjecting mains to the enormous power pressure required, that portion of the system has passed beyond the experimental stage in the supply of hydraulic power in Hull and in London. Mr. E. B. Ellington, M. Inst. C. E., in a paper upon the "Recent Progress in the Public Supply of Hydraulic Power" (reprinted in ENGINEERING NEWS of May 16, 1885,) says that he has subjected pipes to a test as high as 2,500 pounds per square inch, in a 6-inch pipe 1¼-inch thick, and applied the test for some time without any sweating. And on the oil-pipe lines of the Standard Oil Co. wrought-iron pipes with screwed joints are frequently subjected to pressures reaching 1,500 pounds. The pipe used by Mr. Ellington at Hull had flanged connections, so designed as to have a breaking strain of 5,030 pounds per square inch. The valves used are of the balanced valve type, and a 6-inch valve pressed upon its seat with a pressure of 8.8 tons can be manipulated with ease with one hand on a 12-inch lever.

The system was originally applied to Hull as a source of hydraulic power for many purposes, but in 1884, through the use of the Greathead injector, it was employed successfully in the extinction of fire. Mr. Ellington computes as the result of experiment that the useful effect obtained from the power water as applied to a fire stream is from 30 to 33 per cent., according to the initial pressure in the ordinary service. In London, in the neighborhood of Blackfriars and London Bridges, hydrants of the same description are now in use in connection with the hydraulic power mains put into service there in November 1883.

Quaker Bridge Dam and Reservoir.

Reports of the Chief Engineer of the Aqueduct Commission and the Chief Engineer and Consulting Engineer of the Department of Public Works to the Aqueduct Commissioners.

NEW YORK, February 3, 1886.

To the Hon. the Aqueduct Commission:

GENTLEMEN:

In response to your resolution of January 13, 1886, I respectfully submit the following statement of the "reasons why the Quaker Bridge Dam should be constructed:"

In order to intelligently select sites for storage reservoirs above Croton Dam, to increase the delivery of the present aqueduct, a hydrographic survey of the Croton Basin was made in 1857-8. The purpose of this survey was to examine localities where dams could advantageously be thrown across the Croton river, or its tributaries, in order to fill portions of the valley above each dam, and secure sufficient storage to keep the then existing conduit supplied during droughts.

This survey developed fifteen possible sites, from which to select the two or three reservoirs then required.

Two of these are constructed and in use, and the third is now ordered to be built at Sodom. The amount of storage that these three reservoirs hold, viz., 14,700,000,000 gallons, was considered sufficient to insure the full delivery of the old aqueduct during the severest droughts, with a safe margin of storage.

An additional aqueduct was not contemplated when this hydrographic survey was made, and from the fifteen possible sites such were to be selected as promised the most economical and the best results, in order to provide storage for the old aqueduct only.

These three reservoirs were chosen, because rock foundations existed on which to build safe dams. Examinations of the twelve remaining dam sites indicate uncertain foundations. Some have rock at one end, and part of the bottom of the dam, only; the other end butting into a hillside, where rock is probably beyond reach. Examinations of the most desirable ones indicate the rock foundations to be nearly as far below the stream, and involving the same problems as at Quaker Bridge.

Twenty-nine thousand million gallons are now conceded to be necessary upon the completion of the new aqueduct, to re-fill the reservoirs depleted by three successive years of drought. The scheme urged by the lawyers and amateurs, who calculate on an *average*, instead of a *minimum* rainfall, would necessitate for its accomplishment the making of a series of most thorough examinations for foundations, etc.

From one to two years would probably elapse before their construction could be commenced, and if their foundations prove to be such as are now indicated, they would take nearly as long to complete after that time as the Quaker Bridge Dam, for which preliminary examinations and plans are now completed, and nearly ready for execution.

There is, therefore, every reason to believe that, by means of the Quaker Bridge Dam the required storage can be soonest secured. Should the before mentioned upper dams in the plan of the opposition be built, they should be of the most reliable character, because one end of the present Croton Dam below them consists of an earth embankment: therefore, if one of the dams above were to fail, it would inevitably carry away the present Croton Dam. To build them in a reliable manner would involve in a total cost far exceeding that of the proposed Quaker Bridge Dam, involving a greater total expenditure, both of money and time, in order to secure storage needed at once, and would also involve the same (so-called) unknown quantities.

On the contrary, one of the strongest arguments in favor of building the Quaker Bridge Dam is that it will be the very best safeguard against such a disaster, for in the case of the failure of one of the upper dams, its ample spill-way, or waste-weir, would pass the flood without injury to the great dam. Even if it partly passed over the dam itself, as well as through its waste-weir, no serious disaster to the great dam would ensue, as there would then be a waste space of over three thousand feet in length. The reservoir itself would also constitute a great diminisher of the force of the flood, which could but gradually fill this enormous container, raising its surface with sufficient slowness to enable its great spill-way to pass the flood harmlessly. Even if the Croton Dam embankment were injured during such a flood, the city's supply would not be jeopardized. Therefore, if the Quaker Bridge Dam be not built as a protection against such danger, every new dam built increases the danger to the Croton Dam and the city's water supply.

As the extravagant statements made by its opponents of the cost of the Quaker Bridge Dam have been refuted by the ablest engineers, and as three of the financially strongest contractors have expressed their willingness to construct it, at, or below, my estimate of its probable cost, I will only further state that, if my calculation of the expense of the deep excavation for its foundation, so much doubted by non-professionals, were doubled, it would only add $360,000 to the total cost of its construction.

The masonry required can be calculated as closely as to its cost and safety, as that of any other known engineering structure, or of a simple house wall. Although large, it is not experimental in its character. It has been condemned because of its unprecedented magnitude. So is its supplement, the Aqueduct, involving engineering problems of far greater moment, unprecedented in magnitude. For instance, the carrying of the Aqueduct down 150 feet under the Harlem river, in uncertain rock, to sustain a head of about 270 feet of water pressure, is a much bolder engineering problem than any involved in the Quaker Bridge Dam.

The old Aqueduct was also an enterprise without parallel in its day; so, also, was the East River Bridge. But the great amount of storage obtained by the great dam warrants its construction. These results will be secured by it, in less time than in any other way. Being at the mouth of the river, the storage results produced are far in excess of its cubical contents, because the whole flow of the river is constantly restoring, or "paying back," what is drawn out.

A large accession of water due to the sudden rise of the river by short, heavy showers, occurring frequently during droughts (when water is most needed) is now lost over the present Croton Dam. This water would all be caught and stored by the Quaker Bridge Dam. The smaller reservoirs proposed, although aggregating the same in cubical contents, lose the water collected from the 115 square miles below them, which must necessarily run to waste over Croton Dam. This is simply because the Aqueduct can carry but a small part of such flood water. A corresponding waste would also occur from the overflow of small upper reservoirs, which, being shallow, would fill and spill over in flood times, as is the case now at Croton Dam, and the great dam at the mouth of the river is required to stop all such losses. The utilization of the whole water-shed to secure which the new Aqueduct is being constructed, cannot, therefore, be realized unless the Quaker Bridge Dam is built. This makes it the most indispensable feature of the new storage system. If delayed, the march of improvement will take posession of its basin, by the building of a railroad, already projected, and prevent its final accomplishment. Then the heavy expenditures now being made by the City on the great size of the new Aqueduct will be practically thrown away.

As to the purity of the water stored, I would state that, from a personal knowledge as topographical engineer of the surveys of 1857, covering the whole water-shed, and from the 28 years intervening of inspection and careful study of the basin and the river, the water at the sources of the river and its branches is not in as good condition to store as at the lower end of the basin.

The swamps and peat bogs at the head waters of its several branches affect and noticeably discolor it, and the indications are, from comparative chemical tests frequently made, that the water at the lower end of the river is purer and in a safer condition to store than above. This is proven by a comparison of the water of Croton Lake with that of Boyd's Corners Reservoir above.

The water is aerated and purified by its flow through the river, and by mingling with the purer water which enters the river from the lower and best part of the water-shed, causes it to be in the best condition to store far down in the great reservoir at the mouth of the stream. The whole river flows through, and changes the water stored by the Quaker Bridge Dam every three or four months, also rendering it impossible for any part to become stagnant. Furthermore, the plans also provide for securing circulation at all its parts and at all its depths.

One of the reasons assigned by the opponents of the Quaker Bridge Dam for building a number of small reservoirs in the upper part of the water-shed is, in reality, a very cogent plea against building them, and in favor of constructing one large reservoir at the lowest available point of the river. It is urged that, if one of the small reservoirs should become foul, it can be emptied and its basin cleaned. Now, by *their* plan, if one of them should show signs of deterioration, it must be drawn off at once, and possibly lost over Croton Dam. If allowed to remain and become actually impure, there is no way of getting rid of it save by discharging its bad water into the river, to the injury and contamination of the city's entire water supply. It could not be retained in its own basin, because floods would force it into the stream. In the Quaker Bridge Reservoir these conditions are provided for and perfectly controlled in its own basin. It also provides for purifying the reservoir above, for at the first appearance of any impurity in any of them, they can be drawn off and their water purified by aration during flow to and dilution in the great reservoir below, where the water would not be lost.

It has been and still is the practice all over the world to obtain storage in the greatest bulk and depth possible, to preserve its purity. Great depth and bulk lowers the temperature in hot weather far below 70 degrees, which prevents fermentation. If nature had made a dam at Quaker Bridge and formed there this great lake with the Croton river flowing into and through it, no one would have doubted the desirability of utilizing such water for the city's supply.

The above conclusions are drawn from incontrovertible facts, procured by actual measurement for many years of the real flow of the Croton River over the Dam and through the Aqueduct. Calculations based on average rain-fall are unreliable and misleading, owing to atmospheric conditions, evaporations, degrees of saturation of the earth, etc. Measurements of flow give truthful results and alone should be depended upon.

The opponents of the Quaker Bridge Dam base their speculations upon abstract theories, not applicable to the exceptional conditions of the Croton water-shed. They also base their estimates of quantity and of the time necessary for the refilling these small reservoirs on an *average* rainfall, getting thereby an excessive estimate. Experience and common sense show that the *minimum* should be taken, otherwise in a succession of dry years only a limited number of these reservoirs on each stream could be refilled. Thus it will be seen that the conclusions of the Union League Club Committee must be reversed, to fit the facts upon which alone sound engineering deductions can be based. To recapitulate. The Quaker Bridge Dam should be built at once, because:

First.—It is the surest and most expeditious means of securing the required storage.

Second.—Because it will give the purest water.

Third.—Because it gives the best control of storage.

Fourth.—Because it is the best safeguard against the stoppage of the city's supply by a possible failure of dams above, to the injury of Croton Dam.

Fifth.—Because without it the supply of the whole water-shed cannot be secured, and the size and cost of the new aqueduct will be rendered unwarrantable.

Sixth.—Because it best preserves healthful conditions for inhabitants in the Croton valley by keeping the bottom of the reservoir always covered, and prevents local malarial influences.

Very respectfully,
B. S. CHURCH, *Chief Engineer.*

TO BE CONTINUED.

ENGINEERING NEWS
AND
AMERICAN CONTRACT JOURNAL.
TRIBUNE BUILDING, - NEW YORK CITY.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

VOL. XV. Saturday, February 20, 1886.

CONDUCTED BY
GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER M.Am.Soc.C.E.: M.Inst.C.E.

TERMS OF SUBSCRIPTION.
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IN answer to a query from several of our subscribers as to what was covered by the item of "labor" in cost of pipe laying in Boston (see page 84), we have been kindly furnished with the following particulars by Mr. Dexter Brackett, engineer-in-charge of the Boston Water Department. The item of "labor" includes cost of trenching, pipe laying, refilling and rolling. It does not cover the cost of repaving, as the pipe laying is done almost entirely in unpaved streets. Mr. Brackett says that in refilling trenches the material is puddled after the trench is filled and then thoroughly rolled with a grooved roller, so that the street is practically left in as good condition as before the work was commenced.

The item of "total cost" gives the average total cost of laying pipe of the given sizes as the work is done in Boston. But the fact should be taken into consideration that this work is done entirely on petitions for extensions,200 feet in one place and perhaps 500 feet in another, two or three miles distant. The cost is consequently higher than it would be for laying a continuous system.

ACCORDING to the *Boston Herald*, an attempt is to be made to secure the passage of a bill modifying the rates of postage on the annual reports of colleges and all other institutions of learning and all annual proceedings of missionary and benevolent societies, so that, instead of paying as at present one cent for each two ounces or fraction thereof, the payments shall be made at the rate of two cents per pound, or at 4th class rates.

This movement should attract the attention of technical societies throughout the Union; for example the American Society of Civil Engineers and probably many other societies have to pay at the ounce rate, and it is understood that the Society of Civil Engineers would save between $450 and $500 per annum on their publications, if they could be sent at the pound rate, and it does not seem right that gentlemen who are engaged in increasing the world's stock of useful information, should be compelled to pay a higher rate of postage than, say, the *Police Gazette*.

We hope the directors of the American Society of Civil Engineers will move in this matter, and, both through their own members and the co-operation of other societies, support the proposed law.

The Engineer, in commenting on the recent discovery that British bayonets are not what they should be, suggests that some restrictions be put upon their use as pokers and toasting-forks during an active campaign. The advice is good, *per se*; but practically we fear there would be some difficulty in enforcing regulations of that character; the bayonets are only used, when used at all for these non-military purposes, under conditions that are hardly amenable to rules.

THE New York Chamber of Commerce has appointed the Hon. John Bigelow to meet the Commission of Count Ferdinand de Lesseps, which is shortly to investigate the present state and future possibilities of the Panama canal.

This gentleman, who, besides his service to his country as Secretary of the Legation at Paris during a very trying time, has more than the average literary ability, will tell exactly what he thinks he sees. The probable relation between his perspective and the state of the case, however, can be judged of by those who know how thoroughly his views were warped by the clerical reactionists and German merchants of Mexico, during his visit to that country.

As de Lesseps has carefully abstained from inviting guests from any engineering society, it may be wondered that our Chamber of Commerce, which probably prides itself on its practical ideas, should not have sent a representative conversant with engineering operations.

The Boston appointee is Nathan Appleton.

The Making of New Land in Boston.

According to the report for 1885 of the Harbor and Land Commissioners of Boston, the Commonwealth of Massachusetts owned on the Back Bay, in 1857, 4,723,998 square feet of land. Of this area, up to Dec. 31, 1885, 371,708 feet had been donated for various public purposes; 2,035,494 feet had been devoted to streets and passageways, and 2,305,762 feet sold to private parties. The amount remaining for sale on the last date was 11,144 feet.

The gross proceeds from land sold was $5.035,563.42, and the cost of filling, grading, curbstones and expenses of auction sales to date given was $1,641,924.05. The net proceeds were thus $3,393,639.37. The average price per square foot of all land sold on the Back Bay is $2.18, though the average price of sales for some years past exceeds $4.00 per foot.

In the deeds given to private purchasers by the Commonwealth there are restrictions which require all buildings to be at least three stories high, and forbid their use for any mechanical (and on Commonwealth avenue, any mercantile) or manufacturing purpose. The houses must be set back from the street 20 to 25 feet, according to location, and the permissible projection of steps, doorways, bay-windows, etc., is very explicitly laid down in the deeds. A passageway 16 or 25 feet wide is laid out in the rear of all houses which is to contain the sewers of the district.

The streets in this section are filled up and graded, the curbstones set and the gutters paved by the Commonwealth; and the rear passageway will be filled by the Commonwealth but must be kept open and maintained by the abuttors. The State builds the sewers, or causes them to be built, but charges to each abutting lot one-half the expense of constructing the sewer opposite each lot. As the land is filled, the sewers must be built and maintained by the State, but at the expense of abuttors, until the city accepts the street or passageway, when the latter assumes the cost of maintenance. The deeds include a clause prohibiting the erection of stables on this land; but this is now modified so as to permit the erection of private stables as appurtenances to dwelling-houses, but under strict regulations as to method and use.

On the South Boston Flats the Commonwealth has 99.46 acres, 82 of which are now filled to grade 13. In obtaining the filling material 90 acres of the main harbor of Boston have been deepened to 23 feet at low water. The ultimate purpose is to utilize these flats for railway and commercial purposes, and by means of a junction railroad to center here all the lines entering Boston.

The Buildings of New York.

The report of the New York Fire Department, for the year ending December 31, 1885, gives statistics from actual count as to the number and class of buildings in this city, and also as to number and distribution of families in each. We make the following abstract:

In the thirteen districts of New York, extending to the Yonkers line, there are 81,255 buildings used for dwellings exclusively; 22,995 for business exclusively, or a total of 104,250. Including sheds, bridges, piers, etc., the aggregate of all structures is 107,807. Of dwelling houses, 9,588 are more than four stories high; and of business houses, 4,611 are above the same standard.

Classified as to families occupying them, a total of 32,576 contain one family each, and 48,679 buildings contain more than one family each.

The fourth, fifth and sixth districts lie between Chambers and Fifty-ninth streets; cover 4,384 acres and contain 59,273 buildings of all kinds.

Report of the Boston Water Board to Dec. 31st, 1885.

From the report of the Boston Water Board, for the year ending December 31, 1885, we make the following extracts as of general interest:—

The reservoirs, conduits and main pipe lines are in generally good condition; the new reservoir No. 4, on Cold-spring brook, is completed; the completion of the new High-Service works has been delayed by the action taken in regard to the pump contracts, and work on the high-service reservoir will be finished by December 1, 1886. No new work requiring any considerable expenditure of money is contemplated for the present year, though certain matters are being investigated which may be developed during the season.

The Board state that the use of the Deacon Detector system and sidewalk stop-cocks have materially contributed in keeping down the consumption of water to the standard of 1884. The daily average consumption per head was 72.4 gallons for 1885, as compared to

1.9 for 1884 and 94.9 for 1883. In the report of Mr. Dexter Brackett, in charge of this department, we find a tabular statement of reductions effected in the metered districts between the Deacon readings of 1884 and 1885. This table shows that in the year the gallons saved daily per head of population ranged in the various districts from 11 to 39. In some sections where the night waste per 24 hours had been 40 gallons in 1884, this was reduced to 13 gallons in 1885; in others the night reduction was from 69.4 gallons to 21.4.

During the year 1885 about 9,000 of the Church stop-cocks were received and tested, and between May 13 and November 27, 1885, the work being commenced on the first date, 5,584 have been set. The results already obtained show that an accessible stop-cock on every service-pipe is of great advantage in detecting waste. Each service-pipe was tested between 11 P. M. and 4 A. M., and nearly 25 per cent. of the total number so tested were reported for examination. The total waste from the 1,319 services found defective was 38,000 gallons per hour.

The Board report that the affairs of the Meter Division are in an unsatisfactory state. A large number of the meters supplied by the Tremont Meter Co. have been rejected after trial, and the company have yet failed to replace them.

As regards new water supply application has been already made to the Massachusetts Legislature for the waters of the Shawsheen river, to replace the present Mystic supply, which is rapidly becoming contaminated; it is expected to furnish 20,000,000 gallons per day.

Snow Storms and Cable Railways in England.

The Londoners who go to pieces badly on a fall of 5 or 6 inches of snow, are very much pleased with the working of the cable road they have; it was about the only mode of locomotion, except the underground, that was not interrupted during their late storm. *Iron* asserts that they ran without difficulty and that the superintendent wished for more snow so that he could show what he could do, and that on Highgate Hill, grade 1 in 11, where teams of six horses could not pull 4 tons, the vehicles were attached to the cable cars and were drawn up without difficulty.

This is in effect the same experience had last winter in Chicago, until the shaft of their winding engine broke down. In spite of the intense cold, and drifts, said to have been six feet deep, the cable pulled the cars steadily through, until the four 24 × 48-inch cylinders twisted off the shaft of their winding drums. This year they have added two 30 × 60-inch cylinders and strengthened their shaft, proposing to pull their cars through anything that any blizzard may bring.

The Use of Explosives in Sinking Tubular Foundations.

Le Génie Civil, of January 23, in describing the construction of the Palma bridge over the Guadalquivir river is Spain, notes the use of explosives in sinking several of the tubular piers.

Work was commenced in the spring of 1834 upon the foundations, and compressed air was employed on the first pier, which was made up of two cast-iron columns, each 8 feet in diameter. But progress was interfered with by frequent rises in the river to the extent of 16 to 18 feet, and by the fact that the depth to hard bottom was only about 34 feet below the water surface, and the heavy counter-weight thus required to overcome the lifting effect of the compressed air was awkward to handle under the controlling conditions.

M. Jardin, the engineer in charge, finding it impracticable to increase the weight conceived the idea of employing dynamite as an aid in sinking his piers. His method was as follows:—The cylinder being cleaned out and all made ready for a "sink," holes were bored horizontally out under the cutting edge, and cartridges of dynamite inserted. Wanting electrical apparatus the firing was done by fuse cut to a length sufficient to permit the men to escape from the cylinder which was filled with water before firing. The simultaneous explosion of the cartridges produced the intended effect, and the process was repeated, until the desired point was reached.

M. Jardin claims that this method may be applied without danger, provided that the cartridges are placed as far as possible away from the cylinder, which would otherwise be broken. The effect upon the soil was comparable to a light earthquake shock, at times accompanied by jets of water thrown up around the pier; but more frequently, with depths of 27 to 30 feet of earth, the gases of explosion escaped into the interior of the tube without making any outside demonstrations.

The process was applied only to one pier; other methods being adopted for the rest of them.

The Leveling of Siberia.

The results of the Siberian levels, the greatest work of the kind ever attempted, are at last published. The work originated in the Russian Geographical Soc. and had for its purpose the determination of the height of a great part of Siberia above sea level. The preliminary results were known in 1878; the whole length of the leveling from Zwerigolowskaja on the Tobol to Lake Baikal was 2,040 English miles. Unfortunately the starting point is only connected with the Black or Baltic Seas by triangulation alone, and there is an uncertainty in the figures to the extent of 30 or even 40 feet.

Lake Baikal is given as 1,561 feet above sea level; the highest point reached was 2,029 feet, a little east of the river Ud. The elevation of Lake Ladoga was found to be 16.3 feet above the Gulf of Finland, instead of 66 feet as formerly stated. According to the new determination, the slope of the river Neva is about the same as that of the Volga in its middle course, while formerly it was supposed to be four times as great.

The Panama Canal.

The *Bulletin du Canal Interocéanique*, for January 15th, says that Charles A. de Lesseps sailed for Panama on January 6th, accompanied by M. Jacquet, Inspector General and M. Boyer, Chief Engineer *des Ponts et Chaussées*; the latter is director of works at Panama. (Ferdinand de Lesseps sailed for Panama on January 28.)

The report of work done for the months of September, October and November 1885 gives the following amounts respectively:—608,000, 715,000 and 687,000 cubic metres excavated; heavy rains in October and November have delayed the work.

PERSONAL.

RICHARD M. STANTON, a well-known and wealthy contractor and builder, died suddenly in Bridgeport, Conn., on Feb. 16, of heart disease, aged 60 years.

JOHN L. OGDEN was, on Feb. 11, elected by the City Councils of Philadelphia as Chief Engineer of the Water Department of that city. Mr. OGDEN has been in the Water Department for many years as Engineer-in Charge of the distribution and is thoroughly posted in all that relates to this extensive and intricate system.

SAMUEL H. DOTY, formerly Chief Engineer of the Chicago and Atlantic Railway, has been appointed Assistant Engineer of the Fremont, Elkhorn and Missouri Valley and Sioux City, and Pacific railroads (Chicago and Northwestern R.R.) and will have charge of all construction work on the sixth and seventh divisions of the Fremont, Elkhorn and Missouri Valley Railroad and on the Wyoming Central Railway, with headquarters at Chadron, Neb.

NELSON J. BENNETT, the contractor now building the Cascade tunnel on the N. P. R. R., is described as a short, stout, swarthy man, with a heavy black mustache and goatee. He began life in the West as a teamster, but for years past has been at work on the Utah Northern and Western division of the North Pacific R. R. He has also stores in Utah, Idaho, and Dakota, and deals largely in merchandise. He is only 40 years old.

DAVIS COLEMAN has been appointed Superintendent in charge of the Northern division of the Burlington & Northern R. R., with office at La Crosse, during construction. MR. COLEMAN will also have charge of the track laying and construction work generally on the Southern division. C. A. GOODNOW has been appointed Assistant Superintendent of the Northern division, with office at La Crosse, and J. M. BABB Assistant Superintendent of the Southern division, with office at Savannah.

EDWARD BENTON TALCOTT, Civil Engineer, and formerly Superintendent of the Galena and Chicago Union Railway, now the Galena division of the Chicago and Northwestern Railway, died in Chicago on the 8th, at the age of 74.

MR. TALCOTT was born at Rome, N. Y., but became a resident of Chicago in 1835. At 23 years of age he was one of the leading engineers on the Illinois and Michigan canal, and he inaugurated the construction at Canalport by throwing out the first shovelful of dirt. As Engineer and Superintendent he was engaged on the canal until three years after its completion, except the years between 1840 and 1845, when work was suspended. MR. TALCOTT was City Surveyor of Chicago for a term, and in that capacity platted the submerged lands along the lake shore and the dock property along the river, as well as other sections of the city.

He was next engaged for several years in the construction of the Hannibal and St. Joseph railroad, and after its completion he returned to Chicago to become the first Superintendent of the Galena and Chicago Union Railroad, remaining in charge of its affairs until it was absorbed by the Chicago and Northwestern. During this time he constructed the bridge at Clinton, one of the first to be thrown across the Mississippi river.

In 1867 he took charge of the construction of the Grand Rapids and Indiana Railroad, (on which work the senior editor of ENGINEERING NEWS was an assistant engineer on the location from Ft. Wayne to Kendallville) and, though many difficulties and discouragements arose, under which almost any other man would have succumbed, his courage never failed him, and he steadily persevered, until he finally saw it completed. The exposures and hardships to which he was subjected in carrying this line through the almost impenetrable swamps and forests of northern Michigan undermined his naturally vigorous constitution, and in 1873 he was attacked with palsy, from which he was never afterward relieved. Since that time he has lived quietly at his home, constantly suffering, but never complaining. Although not seen in active life, he never lost his interest in matters of public importance, and kept himself fully informed as to the progress of all great engineering works. He followed every detail of the construction of the cantilever bridge at Niagara Falls, and carefully watched the progress of every work in which Chicago was interested.

Although shaken by the palsy for thirteen years, without cessation by night or day, and notwithstanding the fact that he was in constant pain, he never lost his cheerfulness, and never was heard to complain. An indomitable will and calm and steady courage enabled him to bear unflinchingly all that he was called upon to endure.

His tall and erect form, his mild but piercing eye, his cheerful face and bright and genial smile will long be remembered by those who knew him. He was always more careful of the comfort and happiness of those who labored under him, than he was of his own. Conscientious in all his deeds, none ever knew him to be guilty of a mean or sordid action.

THE GULF STREAM CURRENT.—The Canadian Minister of Marine, in co-operation with the French Admiralty, is preparing a scheme for the distribution of iron floats along the Atlantic coast in such a way as to determine the direction and force of the Gulf Stream.

American Society of Civil Engineers.

A regular meeting of the Society was held at its house on February 17th, Mr. J. J. R. Croes presiding.

The evening was devoted entirely to the reading of a paper "On the Construction of the Dam at Holyoke, Mass.," by Mr. Clemens Herschel, the author and the engineer-in-charge of the work described. The paper itself was an exceedingly practical and valuable production, and was illustrated by plans, photographs and models to scale. Mr. Herschel commenced with a description of the original dam of 1849; detailed the effects of the fall in wearing away the soft rock; the building of the apron of 1868, and the efforts made and results accomplished in the repair of leaks and breaks in the covering of the original wooden structure. He then proceeded to detail the operations of 1885 in strengthening and tightening the dam. The old dam was made of square 12 by 12-inch timbers; in section a flat triangle with a vertical downstream face, and sheathed on the upper side with 6-inch hemlock plank; the interior was hollow or unfilled. This old sheathing had become much weakened by decay and by frequent breaks in its surface, causing much wastage of water. The repairs were accomplished by exposing about 20 feet in width of the slope by means of an ingenious system of triangular coffer-dams; the careful placing by hand of strong sheet-piling and the filling of the interior of the dam on each side of the sheet-piling by gravel puddle forced into place by water jets.

The repairs were thoroughly successful and the detail of method, time and cost fully given. A feature of Mr. Herschel's paper was the many practical deductions made by its author from the experience gained, and the common sense manner in which his plans for this hazardous and novel work were arrived at. He laid especial stress on the value of models to the engineer in planning similar work; and says that in this case he spent more time in the carpenter shop than in the drawing room, and gained more valuable experience from experimenting with models than in studying paper plans. The organization of the working force in putting his plans into execution was also most admirable.

American Inst. of Mining Engineers.

The meeting of the American Institute of Mining Engineers in Pittsburg, Pa., this week, was well attended. Mr. John W. Chalfant welcomed the visitors in the name of the citizens and the Engineers Society of Western Pennsylvania, and the President of the Institute replied in an address with "business honor," as his text. At the evening session Mr. Wm. Metcalf, of Pittsburg, spoke on "Natural Gas," and Mr. W. P. Shinn, of New York, and one time manager of the Edgar Thompson Steel Works, read a "Record of Seven Years Progress of Pittsburg and Vicinity."

Visits were made to the plate-glass works at Creighton Station, to the natural gas wells of the Philadelphia Co., to the works of Messrs. Miller, Metcalf & Parkin, Black Diamond Steel Works, etc. On Thursday evening the usual banquet was held, and on Friday further visits were made to examine the Clapp-Griffith plant of Messrs. Oliver Bros. & Phillips, the works of Jones & Laughlin, and the Edgar Thompson Steel Works. A business meeting on Friday evening closed the meeting.

ENGINEERING NEWS, Three Months, One Dollar and Fifty Cents.

Engineers' Club of Philadelphia.

Record of Regular Meeting, Feb. 6, 1886.

President Washington Jones in the chair; 41 members and 2 visitors present.

The Secretary presented, for Mr. A. R. Cruse, a compilation of tests of the efficiency and economy of various Gas Burners.

The Secretary presented, for Mr. Mataro Crizuka, a paper, illustrated by Japanese maps, upon the Railways in Japan. The history of the present railways is given, and the projects for the future. The paper treats of costs per mile; the bridges, tunnels, shops, etc.; the methods of operation; the profits of the traffic; the native and foreign supervision and labor; and the relations of the Government and private enterprise to the work.

Prof. L. M. Haupt read a second paper on Harbor Studies, discussing the action of tidal currents and showing their locus as revealed by the mould of the harbor and the divide or crest-line of the bars. He believed that local efforts to improve the channel across the New York bar would be most successful by utilizing the resulting ebb's scour at the head of Gedney's channel by floating devices for concentration and vertical deflection of the currents there existing, and made a few remarks showing how such floating deflection might be used to regulate the currents of the Mississippi river and so tend to establish a constant regimen.

Mr. J. Foster Crowell read a paper upon the Present Situation of the Interoceanic Canal Question, presenting the subject from a general standpoint. He sketched the history of the various past attempts to establish communication through the American Isthmus, and traced the developments in the different directions of effort, which finally concentrated the problem upon the three projects now before the world, summarizing the progress in each case, and stating the following propositions.

1. That Panama is the only possible site for a Sea Level Canal, and that such treatment is the only feasible method at that place.

II. That Nicaragua is the only practicable site for a Slack Water system (for a canal with locks), and that it is pre-eminently adapted by nature for such a use; that there are no obstacles in an engineering sense, and no physical drawbacks that need deter the undertaking.

III. That the Ship Railway, as a mechanical contrivance, has the endorsement of the best authorities, and may be admitted to be the *ne plus ultra* as a means of taking ships from their natural element, and transporting them over the land.

IV. That none of these plans has as yet advanced sufficiently to warrant our considering its completion as beyond doubt.

V. That, as the *additional* sum now asked for by de Lesseps (*even if sufficient*) to complete the Panama Canal is *greater* than the estimated cost of either Nicaragua Canal or the Ship Railway, it would be economical to abandon the Panama Canal, and the money sunk in it, to date, unless its location and form possess paramount advantages, and we therefore may profitably consider the relative merits of the three lines, without regard to the past, from four standpoints, viz.:

1. Geographical convenience of location.
2. Adaptiveness to all marine requirements, present and future.
3. Political security.
4. Economy of construction and operation.

He then discussed the comparative claims to excellence. In the first consideration, after classifying the several grand divisions of future ocean traffic and noting especially the needs of the United States, he claimed that while there was little to choose, in this respect, between Nicaragua and Tehuantepec, either was far superior to Panama.

In the second particular he maintained that owing to the characteristics of the Panama Canal and the practical impossibility of enlarging it hereafter, excepting at stupendous cost, it could not serve the purposes of the future, although it might, if completed, supply present need. He praised the ingenuity of the plans for the Ship Railway, but emphasized the fact that it will be the *movement of the traffic*, not merely the lifting and supporting of ships in transit, that will test the system and suggested that even the beautiful application of mechanical force which had been contrived might be powerless to insure the high grade of service which is an absolute necessity In this connection the general features of the Nicaragua Canal, in its latest form, were referred to, and the opinion expressed that even were all difficulties in the way of the Ship Railway eliminated, it could not be superior to the canal in respect of adaptiveness.

In point of political security he claimed that both Tehuantepec and Nicaragua were reasonably free from doubts, with the advantage in favor of the latter, while at Panama no security, for United States interests at least, could be counted on, without the liability of a military expenditure far exceeding the cost of the canal itself.

The matter of comparative cost of construction and operation was discussed generally, and in conclusion the author stated that "this all important question is still an open one, of which the future needs of our country justify and demand at this time a most searching scrutiny, and moreover, our interest and the interest of mankind require that before this century closes, the best possible pathway between the Atlantic and the Pacific shall be open to the navies of the world."

The paper was illustrated with maps and diagrams.

In response to requests, from a number of members present, for more detailed information in reference to the engineering questions of the Nicaragua project, Mr. Crowell has agreed to speak on this topic at the meeting to be held February 20, 1886.

The Secretary presented, for Hon. J. Simpson Africa, Chairman, Prof. L. M. Haupt and Mr. A. E. Lehman, Committee, a Memorial of the late Col. James Worrall, giving a very interesting account of his connection with the early and later engineering works of the country.

HOWARD MURPHY,
Secretary and Treasurer.

Compressed Lime Cartridges.

With respect to the compressed lime cartridges which are now used in a good many collieries it may be said that the lime is in a caustic state, made from mountain limestone. This is ground to a fine powder, and consolidated by a pressure of 40 tons into the form of cartridges 2½ in. in diameter, having a groove along the side. These are then packed in air-tight boxes to protect them from the damp, and are sent to the mine. Shot holes are drilled in the face of the coal, and an iron tube half an inch in diameter having a small external channel or groove in the upper side, and provided also with perforations is then inserted along the whole length of the bore hole. This tube is enclosed in a bag of calico, covering the perforations and one end, and has a tap fitted on the other end. The cartridges are inserted and lightly rammed, after which a small force pump is connected with the tap, and a quantity of water equal in bulk to the quantity of lime used, is forced in. The water,

being driven to the far end of the shot tube through the tube, escapes along the groove and through the perforation, and the calico, flowing towards the tamping into the lime, saturating the whole and driving out the air before it. The tap is then closed to prevent the escape of the steam generated by the action of the water on the lime, and the flexible pipe attached to the pump is disconnected. The action of the steam first takes place, cracking the coal away from the roof, and this is followed by the expansive force of the lime. There is no fire or flame, and the coal is got with a very low percentage of small.—*Iron and Coal Trades Review.*

News from Wisconsin.

Special Correspondence ENGINEERING NEWS.

FORT HOWARD, WIS., Feb. 15, 1886.

The Wisconsin and Michigan Railway let a contract on February 13th, to Dawson & Symmes for the extension of their railroad from the present terminus at Pike River to Iron Mountain, Michigan. The object is supposed to be to obtain a share of the ore freights from the iron mines at the latter point. The road (operated by the Milwaukee & Northern Railway) has two ports, Menominee, 64 miles from Iron Mountain and Green Bay, 85 miles from the latter place. The distance by the C. & N. W. Railway to the present shipping port, Escababa, is 50 miles. There are six charcoal blast furnace stocks reached by this road. Contract calls for completion August 15th. C. S. Woodard, Green Bay, Wisconsin, is Chief Engineer.

Work on the northern extension of the Wisconsin P. & S. Railway is now going on between its present terminus and Marshfield. At present the right of way is being cleared, and bridge timber is being gotten out James Hides, Dexterville, Wis., has charge of the work.

A number of wealthy men at La Crosse have recently incorporated a road projected to run from Stevens Point, via Wausau to the pine forests of Northern Wisconsin. It is in rather rough country and its completion beyond Wausau is very doubtful. It is called the Stevens Point, Wausau and Northern. G. C. Hixon, of La Crosse, is President. It will be a feeder to and in the interest of either the Wisconsin Central or the Green Bay Winona and St. Paul railways.

The counties of Door and Kewaunee recently voted adversely to propositions of aid towards building a railroad through their counties, and are now agitating some agreement with the Mil. & Nor. or Mil., L. L. & Western railways, with the same object. The former road has offered, informally, that, if the road is graded and ironed from Green Bay, they will furnish rolling stock for the same, and pay as rental the net earnings above the operating expenses.

Escanaba, Mich., will vote early in March on the question of bonding the city for $80,000 to build a system of water works.

Marinette, Wis., is increasing the power of their electric light plant from 45 to 110 arc lights. It is of the Brush system, and owned by a local company and operated by water power.

Quite a fight is in progress at Green Bay, Wis., between the Gas Co., which has long enjoyed a monopoly of lighting the city's streets and a newly organized Electric Light Co. over street lighting. At present the propositions are in the hands of a Committee of the Common Council, who are listening to arguments from both sides.

It has been currently reported, but not on very good authority, that Albert Como, of Milwaukee, and others would soon begin boring for natural gas, either in Marinette county, Wis., or Menominee county, Mich., near the cities of those names. The opinion has been expressed within the last few years that it would be found in this locality, and the opinion of a Pennsylvania operator has been quoted in its support, so there is no reason to disbelieve the rumor.

AN ADIRONDACK MOUNTAIN ROAD.—ALBANY, Feb. 17.—The Northern Adirondack Extension Railroad Company was incorporated to-day to construct a railroad from St. Regis Falls, Franklin County, in the line of the southern terminus of the Northern Adirondack Railroad Company in a southerly direction through townships 10, 11, 14 and 17 to a point at or near the base of Buck Mountain, distance twenty-four miles. The capital is $300,000, divided into $100 shares. The directors are: L. B. Bunnell, Theodore V. Sand, H. Q. French, Walter Mason, New York; William C. Kellogg, Edward W. Louis, Charles F. Ketchum, Brooklyn; George Munger, William C. Benedict, A. F. Barlow, A. B. Conklin, William M. Terry, Samuel C. Trubee, Brooklyn.

LITERATURE.

Journal of the Association of Engineering Societies. Vol. 5, No. 3, January 1886.

CONTENTS:—"A Rational Policy of Public Works," by L. E. COOLEY. "A Description of the Charlottesville Water Works, Albemarle Co., Va., by EDWARD D. BOLTON. "Amount of Horse Power used in Propelling Street Cars," by AUGUSTINE W. WRIGHT.

Journal of the Franklin Institute. Vol. cxxi, No. 722. Feb. 1886.

CONTENTS:—"Electricity in Warfare," by Lieut. B. A. FISKE, U. S. N. "Coal Tar Distillation," by Prof. S. P. SADTLER. "The Production of Aluminum and its Alloys in the Electric Furnace," by E. H. COWLES. "A new Application of the Principle of Composite Photography to the Identification of Handwriting," by PERSIFOR FRAZER. "The Law of Condensation and Expansion of Steam in Single and Compound Cylinders," by PROF. WM. DENNIS MARKS. "Rapid Transit and Elevated Railroads, with a Description of the Meigs' Elevated System," by F. E. GALLOUPE. "Recent Tests of Incandescent Lamps," by WM. P. TATHAM.

Annales des Ponts et Chaussées. Nov. 1885.

CONTENTS:—"The Pressure of Earth Embankments." This is an elaborate, illustrated article of 208 pages of the magazine named: it treats the subject mathematically, graphically, and by experimental research.

Elementary Graphic Statics and the Construction of Trussed Roofs. A Manual of Theory and Practice. By N. CLIFFORD RICKER, M. Arch., Prof. of Architecture, University of Illinois, F. A. I. A. etc, New York, William T. Comstock, publisher, 1885. 9×6 in. pp. 153. Price $2.00.

This work is intended as an aid to the student and draughtsman and as a book of reference to the architect. The matter treated includes elementary graphic statics; general construction, loads and pressures, the Ritter and graphical method of moments, length of truss members and formulae, tables, sectional dimensions of truss members and details of truss joints. While this work is intended for the instruction of students it contains much matter of practical interest and will doubtless be useful to anyone interested in the subject.

The Practice of the Improvement of the Non-Tidal Rivers of the United States, with an Examination of the Results thereof. By Capt. E. H. RUFFNER, Corps of Engineers, U. S. A., New York, John Wiley & Sons, 1886; 9×6 in. pp. 195, Price $1.25.

Capt. Ruffner has in this work brought together an immense amount of information relating to the improvement of the non-tidal rivers of the United States, in great part statistical and abstracted from the 32,000 pages of the reports of the Chief of Engineers from 1867 to 1884. It is a concise statement of facts and is practically intended as a guide to members of Congress and others who have to form conclusions upon the expediency of public works, but who have neither time nor inclination to study the subject to its root. To this class it must prove useful. To engineers and others studying the solution of like problems, as here presented, the general detail of work done will be valuable.

Mechanical Integrators, including the various forms of Planimeters. By PROF. HENRY S. H. SHAW. Reprinted from Proceedings of the Institution of Civil Engineers. Van Nostrand Science Series No. 83. Price 50 cents.

This is a useful production treating very fully of the theory and practical use of the Amsler and other forms of planimeters, the text being well illustrated. Considering the many useful purposes to which these instruments can be applied, the issue of Prof. Shaw's treatise in the handy present form should be appreciated by engineers.

SEWER contractors will be interested in the Proposals for the Works at Long Branch advertised elsewhere this week.

CORRESPONDENCE.

Correction.

WASHINGTON UNIVERSITY, ST. LOUIS, February 15, 1886.

EDITOR ENGINEERING NEWS:

In your current issue, February 13th, you reprint an article on "Base Line Measurements" from the *Journal of the Association of Engineering Societies*;—you have the author's name wrong—it should be,

Yours very truly,

J. B. JOHNSON.

Graphical Statics.

NEW YORK, February 13, 1886.

EDITOR ENGINEERING NEWS:

I have studied and used "Graphical Statics" for a number of years and greatly to my advantage. And though many works may be more elaborated, I know of none to compare, in clearness of presentation of the subject, to the work of Prof. A. J. Du Bois, C. E., of New Haven. And want of clearness is the almost fatal defect of most of our works on bridges. Yours,

CHAS. J. BATES.

German Trade Rivalry.

NEW YORK, February 16, 1886.

Editors ENGINEERING NEWS.

The article in your issue of the 13th inst. showing the relative advance in the production of pig iron by the chief makers of that commodity, should call the attention of all who are interested in transportation, or the employment of either skilled or common labor, to the great change in the status of German industries and the serious menace that this change makes not only to what England has long considered "the natural order of things," but also to our own interests, for, aside from England's possession of more convenient and ready access to the markets of the world, by means of her subsidised steamship lines, we "cutting with a sharper and better axe," have long been a successful competitor of hers in such manufactured products as required the use of skill and machinery. We are particularly dangerous rivals in all railroad machinery and appliances, as you have from time to time set forth, and England has had sale for such articles *only* through the close connection that has obtained between her engineers, manufacturers and capitalists, each mutually looking out for the interests of the others.

But English papers, which are prompt to see and call attention either to dangers threatening British markets or advantageous openings for them, have already seen the German threat to their interests in China, and, speaking of the proposed Chinese loan of $175,000,000, one of them says:

"But it is serious for us to find that the issue will be made by the Rothschilds, and that Herr Krupp and several German financiers are the prime movers in the matter. This recalls the time when British manufacturers used not only to construct the railways abroad, but also financed them, *and the financing assured us of the work.* Now apparently the German manufacturers are assuming the same role, and we may be sure that Herr Krupp and his associates will take good care that most of the money is spent in Germany, and that Essen will get the work. The Germans have made great efforts to obtain the first foot in the Celestial Empire, and it would seem that they have been beforehand with us. *The nation that is first in the field we know has generally the best chance of doing business afterwards,* and it behooves British producers to be up and doing, in order to prevent Continental competitors stealing further marches upon us."

This march will not be stolen alone upon England for we can shake England out of her own markets. I fear it will be stolen upon us. Germany, as is well known, has displaced England as the chief servant of Mexico, and it is yet an open question, if even with the advantages which railroads give us, we can displace the Germans there; in China the task would be still harder for us, as Germany will have the first foot there, for we who have always dissipated our industrial forces as is wastefully proposed in the bill to have *two* separated government gun foundries, have neither the concentration nor organization of capital and interests that is represented by Herr Krupp and the Rothschilds, and our capitalists sit supinely, with money at 1½ per cent., and engineers and laborers out of work, because there is no large firm able to step forward as the owner of Essen does and open a way for our present industries and future commerce.

I think it may be doubted if the German iron industries will progress through the next 19 years, as your

table shows they have in the past. Bismarck and the Emperor William can not retain control much longer, and the Crown Prince who is known to be a better educated man than his father, will have sounder views on economic questions than those which have governed the German policy lately, but the German manufacturers have such a start that it is probable they will be our most formidable rivals for some time to come. X. Y.

Ohio News.

URBANA, O., February 15, 1886.

Special Correspondence ENGINEERING NEWS.

Hardin county has a ditch about five and one-half miles long, estimated at about sixteen thousand dollars, now in the County Commissioners' hands for examination of assessments, which will probably be sold at an early date.

The friends and officers of the Miami and Erie Canal recently held a meeting, and elected officers. A committee of three were appointed to memorialize the Legislature to appropriate $20,000 for three dredges to be used in keeping the canal in good condition. Strong resolutions were passed, protesting against the Board of Public Works diminishing the number of employés, and dividing the entire length from Toledo to Cincinnati into two sections, instead of three, as at present. Resolutions were passed petitioning the Board to appoint only such men superintendents, as are skilled in the handling of men and materials. A committee was appointed to prevent filth and garbage being thrown into the canal.

A proposition has been submitted to the City Council of Delaware, O., by W. S. Kuhn and J. W. Donavin, to construct a system of water works. The work proposed includes the laying and maintaining of not less than ten miles of iron pipe, ranging from 4 to 14 inches diameter, the construction of a substantial brick building with two engines whose capacity shall be not less than 3,000,000 gallons per day; the erecting and maintaining of 120 double delivery fire hydrants, not farther apart than 450 feet; the company to furnish water for the fire-hydrants, city buildings, public schools, and all fire cisterns, for which the city is to pay $5,000 per annum. The City Council is debating whether they shall issue a perpetual franchise to the company, or whether the works shall be built and controlled by the city.

The search for natural gas and oil in Ohio goes on unabated, and some of the results are remarkable. At Findlay there are thirteen wells, and the light of the burning gas can be plainly seen from Kenton, nearly thirty miles away. Interested persons are preparing to pipe it to Fostoria and Toledo. Bucyrus has found gas, and Sidney is reported to have a well from which 200,000 feet are escaping daily. Some of the wells flow on unchanged when others near by are bored, some fail, and occasionally the flow is said to be increased. Lima has twenty rigs up, and more are projected. Delaware has organized a company and will begin active operations at once. In Cincinnati has been formed the Interior Oil and Gas Company.

The Cincinnati, Van Wert and Michigan Railroad has been changed to the Cincinnati, Jackson and Mackinaw Railroad.

The Dayton and Ironton is to be widened from a narrow to a standard gauge.

The Baltimore and Ohio, it is reported, will now establish the long talked of new division from Wheeling to Charleston, W. Va., which will be known as the Wheeling Junction R. R.

The following from the *Dayton Journal* is of interest to surveyors in search of ancient marks in trees by which to establish boundaries: After a careful study of the subject, Prof. P. D. Penhallow concludes that the formation of the so-called "annual rings" of growth in trees is chiefly determined by whatever operates to produce alternating periods of physiological rest and activity. In cold climates the rings are an approximately correct, but not always certain, index of age. In warm climates, however, the rings are of no value in this respect, as the growth is more likely to mark a period of rainfall than the yearly hot season of summer.

This view is supported by the Agricultural Department at Washington, which finds that trees of six years showed twelve rings; of twelve, twenty-one; of five, eleven, and of twenty-four, twenty; the trees being respectively locust, hickory, crabapple and oak.

The people of Cincinnati have been promised improved streets at an expense of four millions of dollars. The first step was taken the last of January, when the Board of Public Works awarded work amounting to $997,360.83. The awards were as follows: F. H. Kirchner, granite pavement, concrete foundation ten inches thick, $33,689.99; same, granite pavement on stone foundation, $2,352.55; Frank Kirchner, granite pavement on ten-inch concrete foundation, $181,258.94; John O'Brien, granite pavement on ten-inch concrete fonndation, $117,767.84; Folz & Ashman, granite pavement on ten-inch concrete foundation, $321,590.03; M. S. Forbes, granite pavement on limestone foundation, $340,701.48.

The guard of the Governor of Ohio is reported to be organizing a battery of Gatling guns.

Three powder mills at Xenia blew up recently, and the explosion is supposed to be due to the incrustation on the large rollers which had not been in use for a few days.

The following is suggestive in regard to new discoveries not only in Ohio but elsewhere: "There are no joys without their sorrows; there are no advantages without disadvantages, and the finding of natural gas and petroleum oil in Ohio has inspired a spontaneous, gigantic and alarming growth of monumental and stupendous liars, such as the Buckeye State never before harvested. Leipsic claims to have drilled through a vein of virgin gold; Bluffton has discovered a great lead mine; Delphos thinks she has discovered water; Lima is sure of a 200 foot vein of pure marble, and when one of her citizens smells burning leather or a rubber boot, he straightway telegraphs to the world that one of her plugged wells has bursted out, sending a plug four feet in diameter, completely out of sight, and that "the well is now 'doing,' 1,560 barrels daily, throwing a solid stream of oil clear to the clouds!" Truly' Sam Jones' visit to Ohio is timely! Portland, Ind., *Sun*."

Illinois News.

Special Correspondence ENGINEERING NEWS.

CHAMPAIGN, ILLS., Feb. 17.

The highway commissioners of Round Grove township, Livingston county, will build a highway bridge in that township soon.

A new coal mining company has been incorporated at Taylorville; capital, $30,000.

The Freeport council has granted a street railroad franchise to H. G. Northrop, vice-president and general manager of the New York Construction and Improvement Company, to construct and operate a street railway in Freeport. The road is about three miles long, and to be in operation in the early summer.

It was announced in this column last week that a movement was on foot in Henry county to improve Greene river for drainage purposes; latter information is to the effect that similar improvements are contemplated for Edwards river in the south part of that county.

Articles of incorporation were filed Wednesday, with the Secretary of State by the Elgin, St. Charles & Southern R. R. Co., with a capital stock of $250,000, and the principal office to be located in St. Charles. The purpose is to construct a railway from Elgin to Geneva. The incorporators and first board of directors are George S Bowen, of Elgin; Charles H. Hines, Henry T. Rockwell, Nathan S. Carlisle, James T. Robinson, J. B. T. Wheeler and Edward H. Bowman, of St. Charles.

The repair bill for maintaining a trifle over one thousand square yards of brick pavement in Bloomington for the first nine years was $30. This pavement was the first laid, and if very much inferior to in every way to any since laid.

Indiana News.

Special Correspondence ENGINEERING NEWS.

CHAMPAIGN, ILLS, Feb. 17.

Michigan City is seriously contemplating the putting in of an electric light plant.

The experiment of coking bituminous coal slack has been successfully tried in Parke county, and a company organized for such manufacture. This means that what has been hitherto simply waste can be turned to considerable profit.

Crawfordsville has temporarily postponed letting the contract for street lighting.

At a depth of 280 feet gas has been struck in the new well, being sunk by Hon. W. C. DePauw, about 18 miles west of New Albany. The flow is the heaviest yet developed in Indiana, but not yet sufficient for piping to the city. There is enough of it, however, to run the salt works Mr. DePauw will establish at that point. It is believed if a depth of 2,500 feet is gone to, there a sufficiently abundant flow of gas will be struck to justify piping it to New Albany.

A new company has been organized in Terre Haute to build new water works.

Nebraska News.

OMAHA, Feb. 13, 1886.

Special Correspondence ENGINEERING NEWS.

There has been a new arrangement in regard to the letting of paving contracts in this city. Heretofore it has been customary for the property owners on the streets to be paved, to select the material desired for paving, and the Board of Public Works would advertise for bids. By this way of doing business the property owners were almost in the dark as to the cost of the pavement wanted. But now bids are first advertised for, and then the property owners select such material as they desire. In this way they can tell just what the paving of the street will cost, and can act understandingly.

In accordance with this plan the Board of Public Works received and opened bids on the 8th. The result of this plan is highly gratifying to the property owners, for in every instance there was a reduction in the prices obtained under the old method.

There were altogether eight bidders on paving, covering specific rates for each of the proposed paving districts for Sioux Falls granite, Colorado sandstone, asphaltum, cedar blocks and several patented wooden blocks. The lowest bids on the several paving materials are as follows:

SIOUX FALLS GRANITE.

On sand, J. E. Riley, price per yard	$2.53½
On broken stone and sand, J. E. Riley, per yard	2.87½
On concrete, Murphy, Creighton & Co	3.28

COLORADO SANDSTONE.

Murphy, Creighton & Co., on sand	$2.61
Murphy, Creighton & Co., on stone and sand	2.89
Murphy, Creighton & Co., on concrete	3.18

CEDAR BLOCK WITHOUT GUARANTEE.

Murphy, Creighton & Co. on sand and plank per yard	$1.22
On stone and sand	1.41
On concrete	1.68
On five years' guarantee; cedar blocks on plank and sand	1.42
Cedar blocks on stone and sand	1.66
Cedar blocks on concrete	1.88

MACADAM.

J. E. Riley, with one year's maintenance—per yard	$1.83
Ryan & Brennan, with five years' maintenance—per yard	2.19

The Macadam has a 4-inch covering of broken Sioux Falls granite, Kerr's patent wooden block pavement.

S. P. Folsom & Co., five years' maintenance—per yard	2.35
S. P. Folsom & Co., ten years' maintenance—per yard	2.50

ASPHALTUM.

Murphy, Creighton & Co.—per yard	$2.95

The bid of the Barber Asphalt Company for asphalt, on the same conditions as those of Murphy, Creighton & Co., was $3.15 per yard. The Barber Company was somewhat surprised at the bid of their competitors on asphalt paving, but was told that it meant war to the knife or paving.

The Plattsmouth Board of Trade is working up a scheme to organize a stock company of $25,000 capital stock and build a three story brick block, the lower floor to be used for business purposes, and the upper floors to be donated free for the use of the county offices and court rooms.

Omaha will open her new Exposition building on the 18th. It is located in the central part of the city and has a frontage of 120 feet on Fourteenth and Fifteenth streets each, and 260 feet on Capitol avenue. It is two stories high, contains 1,000,000 bricks, and cost $50,000.

The Omaha Gas Co. has just completed their receiver; it has a capacity of 300,000 cubic feet.

The Douglas County Commissioners are investigating a scheme to turn the course of the Elkhorn river into Pappilon creek. In order to furnish better water power to Omaha, Mr. Dan Condon has informed them that he would undertake the job of bringing the Elkhorn river into Omaha for the sum of $1,000,000. His estimates are for a canal 110 feet deep, 40 feet wide at the bottom and 60 feet wide at the top. A.

Foreign News.

(From Herapath's Journal.)

It is stated that negotiations are proceeding between the local Government and the representative of a financial syndicate in London for the sale of the existing railways in British Burmah to a Company, which would also be bound to construct an extension from Toungoo to Mandalay, and thence to Bhamo. The terms of the proposed scheme are substantially the following: The purchase money for the existing railway and the cost of constructing the extension will amount to about £6,000,000. India is to provide the land required for the line, free of cost, and to guarantee 4 per cent. interest on the capital for the first five years and then 3½ per cent. India will have power to take over the line after 35 years, after payment of the capital cost actually incurred.

A company has been formed at Amsterdam for the purpose of draining the Zuyder Zee. The water, which will have to be pumped out, after a sea wall has been built, covers a space 45 miles by, at its widest point, 3

miles. On the line of the proposed cut-off, there is a series of islands which will greatly shorten the wall that will have to be built; but even so, the work is one of stupendous magnitude. The whole area cannot, of course, be drained; the lowest depressions must remain as reservoirs for the drainage of the land to be created.

Correspondence from St. Petersburg states the Russian Government will expend 5,000,000 roubles in the course of 1886 in the completion of the Russian railway network. The following new lines are to be constructed: Baronowitschi and Bielostok, 196 verstes in length, estimated cost 2,737,000 roubles; Brest and Cholm, 105 verstes in length, estimated cost, 4,092,000 roubles; Gomel and Briansk, 359 verstes in length, estimated cost 8,100,000 roubles; Sedlez and Malkin, 63 verstes in length, estimated cost 2,834,000 roubles; Romny and Krementchug, 198 verstes in length, estimated cost 4,015,000 roubles. A line is also in contemplation from Samara to Oufa, 454 verstes in length, and estimated to cost 8,745,000 roubles.

Advices have been received from India by cable, to the effect that a concession has been granted by the Mysore Government for the construction of a loop line of railway, about twelve miles in length, commencing at the Colar Road station of the Madras Railway, traversing nearly the entire length of the Mysore goldfield, and joining the Madras line again at a point near the Camassamudrum station, thus connecting the whole of the Mysore Gold Mines with the Madras Railway system. The works will be undertaken by Messrs. Punchard, McTaggart, Lowther, and Co., the well-known engineers and contractors, whose engineering staff will leave almost immediately for Mysore, to survey and construct the railway, which will probably be completed ready for traffic toward the end of this year.

THE HISTORY AND STATISTICS OF AMERICAN WATER WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.; M. INST. C. E.

797.—MOBERLY, MISSOURI.

Moberly, Randolph county, Missouri, in lat. 38° 30' N., long. 93° W., is on undulating prairie land. Settled in 1869, it was incorporated a village in 1870 and a city in 1872. Water works were built in 1885 by a private company after plans of C. S. Masten, C. E., taking the supply from springs in the bed of a deep ravine, as inforced by the rainfall of a square mile of broken country, the soil of which is underlaid with rock at a small depth. The water is impounded by a clay dam 35 to 40 feet high, and 12 feet wide, on top with slopes of 2 to 1, with a heart wall of stone masonry 2.5 feet wide at top and 10 feet at bottom, founded on and set into the rock 16 feet below the bed of the ravine.

The water is pumped directly into the mains by two Worthington steam pumps, one of 750,000 gallons daily capacity, under 50 to 60 pounds pressure for ordinary service, and the other of 1,250,000 gallons daily capacity, under 120 to 130 pounds pressure for fire service.

Distribution is 6¾ miles of cast-iron pipe of 14 to 6 inches diameter, with 71 fire hydrants, 88 gates and 400 taps. The town pays $6,000 per year for hydrant service.

The works have cost $125,000, and the bonded debt is $100,000 at 6 per cent. interest.

The population in 1880 was 6,070, and is now said to be 9,061.

A. M. Porter is Secretary and J. Faersler, Superintendent.

798. DEADWOOD, DAKOTA.

Deadwood, Dakota Territory, in lat. 44° 30' N., long. 103° 15, W., on Whitewood creek, is in a broken, rocky region. Settled in 1876, it was incorporated a city in 1883. Water works were built by a private company in 1879, after plans of R. D. Millet, taking the supply from Whitewood creek, which has about 120 square miles watershed. At a point 180 feet above the level of the town, the water is taken from the creek by a wooden flume of 1½ inch lumber, laid two feet underground, and led into three wooden tanks each 50 by 20 feet, and 10 feet deep, all connected by 6-inch pipes, with gates which enable either or all of them to be used at one time. The tanks are set on the ground and made of timbers 16 inches square, with posts two feet apart framed into sills and caps and lined with 4-inch plank. Distribution is by 3½ miles of wrought-iron pipe of 10 to 1½ inches diameter, with 16 fire hydrants, 8 gates and 150 taps. The city does not pay for fire-service. The daily consumption is three miner's inches, or 50,175 gallons. The works cost $62,000. There is no debt. The annual revenue is $7,000.

The pipes, having been laid only three feet underground, freeze in the winter very often. The population is about 4,000. The works are leased and operated by James M. Brelsford.

799. CHICO, CAL.

Chico, Butte county, California, is on Chico creek, 96 miles north of Sacramento, in a rich farming district. Water works were built by a private company in 1875, taking the supply from wells and pumping it by steam directly into the mains, with three miles of cast-iron mains, with 33 fire hydrants and 274 taps. The town pays $200 per year for fire service. The daily consumption is 250,000 gallons. Water is used extensively for irrigation, and the service pipes are of 1-inch wrought-iron pipe.

The works cost $50,000. The annual cost of maintenance is $3,000 and the revenue from water rates, $9,800. A. H. Chapman is President, and G. W. Henderson, Superintendent.

No. 7. Water Pressure in Mains of Various Cities.

COMPILED BY J. J. R. CROES. FROM SPECIAL RETURNS, JAN., 1886.

Town and State.	Topography.	Difference of level in town.	In Business District.		Fire Pressure.
			Day Pressure.	Night Pressure.	
		feet.	lbs.	lbs.	lbs.
Baltimore, Md.	hilly.	214	50	70	50 to 70
Columbus, O.	level.	50	40	40	80 to 90
Hartford, Conn.	hilly.	50 to 75	65 to 70	75 to 80	65 to 80
Indianapolis, Ind.	level.	——	45	45 to 50	100 to 110
Kansas City, Mo.	hilly.	150	90	110	120 to 140
Lowell, Mass.	hilly.	——	50 to 65	50 to 65	50 to 65
Milwaukee, Wis.	hilly.	75 to 140	35 to 40	45 to 50	35 to 50
Minneapolis, Minn.	level.	20	45	45	120
Montreal, Que.	level.	60	65	68	65 to 68
Nashville, Tenn.	hilly.	60	50	45	45 to 50
Newark, N. J.	hilly.	45 to 225	23	25 to 29	23 to 29
New Haven, Conn.	level.	25	25 to 30	30 to 50	25 to 50
New Orleans, La.	level.	0	25	10 to 12	10 to 25
Paterson, N. J.	hilly.	40 to 50	25	35	25 to 35
Philadelphia, Pa.	hilly.	400	10 to 25	25 to 30	10 to 30
Providence, R. I.	plateau.	50 to 140	69	69	69
Richmond, Va.	hilly.	40 to 70	40	——	——
Rochester, N. Y.	rolling.	——	30 to 40	40 to 60	50 to 125
St. Louis, Mo.	undulating.	80 to 100	25 to 45	40 to 55	25 to 55
St. Paul, Minn.	hilly.	10 to 240	45	45	45
Syracuse, N. Y.	level.	0	40	45	40 to 45
Toledo, O.	level.	20	50	——	95 to 100
Toronto, Ont.	sloping.	35 to 172	80	80 to 90	75 to 95
Washington, D. C.	level.	50	24	——	——
Worcester, Mass.	hilly.	50 to 75	70 to 75	77 to 80	90 to 165

WATER

NATICK, Mass., is in favor of the proposed State drainage plan.

GEORGE C. MORGAN has the contract for constructing a complete system of water works at Taylorville, Ill.

WATER works machinery will be wanted at Cairo, Ill., and Goldsboro, N. C.

THE system of water works at Woodsville, Mass., which have been completed at a cost of $3,500, were put in operation on the 10th inst.

HENRY R. WORTHINGTON Co. has sued the City of Boston for $100,000 for alleged breach of contract made by William A. Simmons, late Water Commissioner, for high service pumping engines.

HASTINGS, NEB., has adopted the plans and specifications, for water works, of A. A. Richardson, of Lincoln, Neb., for a well and pipe system, standpipe and machinery, and the plans submitted by the Birkenbine company of Philadelphia, for engine and boiler house and stack. The whole cost of the system will be $81,000.

SEALED proposals will be received at No. 354 Superior street, Cleveland, O., until 2 o'clock P. M., February 24, for furnishing and delivering about 3,800 feet of 30-inch cast-iron water pipe, with the special castings that may be required in laying such pipe.

Proposals will also be received at the same time and place for furnishing, delivered at that city, such quantity of cast-iron water pipe, from 3 inches to 12 inches in diameter, with the special castings that may be necessary in laying the same, as may be required during the season of 1886.

THE Board of Health, of Elmira, N. Y., on the 10th declared a cement pipe sewer, built at a cost of $10,000 by the State to carry off the refuse of the Reformatory Gas Works, a nuisance, and on the 11th, a crowd of people led by Alderman Hall, and, in the presence of the Health Officer of the city, broke into the sewer and filled the broken ends with brick and debris, rendering the sewer useless for the present.

THE WATER WASTED IN BOSTON.—BOSTON, MASS., Feb. 17.—Observations by the Boston Water Works Board show that the recent rain fall varied from 4.64 to 6.00 inches. The water gathered in the Sudbury River reservoir and washed over the dam during the four days ending February 15th, amounted to 5,120,000,000 gallons, equal to a depth of 4 inches over the entire watershed, an amount larger than ever before recorded in the same length of time. On the 13th the yield of the river was 2,000,000,000 gallons. At Lake Cochituate 200,000,000 gallons per day are being wasted at the outlet dam, and the total amount received in the lake from the 12th to the 15th inclusive was 1,350,000,000 gallons. The water received in the lake and Sudbury reservoirs during the four days would, if saved, furnish a supply for the city for eight months. At Mystic Lake 650,000,000 gallons were wasted on February 13th, and the total yield of the watershed for the past five days has been 2,060,000,000 gallons, or nearly one-half as much as was collected during the whole of the year 1883. The flow at the Mystic Dam on February 13th was more than double that of any day since January, 1877, when the records were commenced.

NEWPORT, Ark., is discussing the building of water works.

THE Denison City (Texas) Water Works Company was incorporated on the 10th inst. Capital stock $200,000. Denton Duryea, President; Emil Wolton, Secretary; E. W. Abendroth, Treasurer, all of New York.

FRANKLIN, Mass., Feb. 14th.—In addition to the immense losses resulting from the floods, the large Cumberland dam of the Pawtucket water works, built last fall, was swept away yesterday, causing a loss of $100,000.

THE Smith & Welty Reservoir, Fish and Ditch Company, of Colorado, has filed articles of incorporation. Its objects are constructing and maintaining a ditch, water to be taken from the Home Supply Ditch. Also the cultivation of fish for sale in Weld county. The capital stock is $2,000, and its incorporators are Wm. T. Smith, Jacob Welty and Sarah A. Smith.

THE Homer & Cortland, N. Y., Gas Light Company has made a proposition to the village trustees to lay gas mains on the streets west of the railroad and east of the river, and to clean, light and keep in repair all lamps that shall be put up along these mains. The matter will probably be laid before the voters at the coming charter election.

MR. RUDOLPH HERING delivered a lecture on "The Principles of Sanitary Plumbing," in the hall of the Franklin Institute, Feb. 12. His lecture was illustrated with many diagrams of different forms of sanitary apparatus, and many specimens of the most approved forms of basins, sinks and traps were exhibited.

A PUMPING station for drainage purposes will be established at Woodlawn, in the village of Hyde Park, Ill. The district to be drained consists of 753 acres, and works with 50,000 gallons daily capacity will be constructed. The main drain will be of brick, 60 inches in diameter, and will empty into Lake Michigan. The total expense will be about $100,000.

WROUGHT VS. CAST-IRON.—Buffalo manufacturers of cast-iron pipe object to the city engineer of Pittsburg, saying that only wrought-iron pipes should be used for natural gas. They admit that such is probably the best for long mains for leading up and down hill, but they claim that cast-iron is equally good for street mains, and say that all of their cast pipes are tested up to 300 pounds pressure, which is high enough.

THE Sharpsburg, Pa., Council, has adopted the plans for water works submitted by Engineer Schneller. They provide for two pumps of 3,000,000 gallons per day; a double reservoir with a capacity of 2,000,000 gallons, which is not likely to be built at present. The main pipes are fourteen inches with branches six and eight inches in diameter. The supply will be drawn from between Six-Mile Island and the north shore of the Allegheny.

THE supply tunnel to the well and water collectors of the Abilene, Tex., Water Works Company, is nearing completion. When finished it will be nearly 600 feet long, and is expected to drain the whole underground flow of the valleys of both Cedar and Lytle creeks. In securing this enormous quantity of water in addition to the present supply, the company is evidently anticipating in Abilene a city of large proportions. All the water mains have been laid through the business streets, and work is now being pushed in the resident portion of the city.

More than 300 years ago an English historian gave the following description of a saw-mill: "The saw-mill is driven with an upright wheel, and the water that maketh it go is gathered whole into a narrow trough, which delivereth the same water to the wheels. This wheel has a piece of timber put to the axle-tree end, like the handle of a broch, and fastened to the end of a saw, which, being turned by the force of the water, hoisteth up and down the saw, that it continually eateth in, and the handle of the saw is kept in a ringall of wood from swerving. Also the timber lieth, as it were, upon a ladder, which is brought by little to the saw with another vise."

A LARGE gathering of the citizens of Montclair, N. J., was held last Monday evening at Montclair Hall to hear the report of the commmittee of Fifteen appointed to consider the feasibility of introducing a water system and also a system of sewerage. Thomas Russell, the representative in the United States of Clark's Mile End thread, was chairman, and a report was read which recommended that steps be taken to introduce water throughout the most thickly settled parts of the village. It is proposed to obtain the supply from the basin around Verona Lake, about a mile and a half west of Montclair, between the mountains, by the sinking of artesian wells, thus obtaining the same source of supply that feeds the lake. The cost of laying the mains will be about $95,000 and is to be raised by the formation of a stock company composed of residents of the place. The question of sewerage was laid over until the next meeting.

ATLANTA, GA., Feb. 12.—At a meeting of the Water Commissioners and the Committee on Water Works, held to-night, it was decided to put down three miles of water pipe, to distribute the flow of water from the artesian well. The Council will endorse the action of the Commissioners and Water Works Committee, and pipes will be laid at once.

BUFFALO, N. Y.—It is proposed to put in another pump at the water works this year. The city last year laid pipes for 7,000,000 gallons daily supply, which makes the whole system capable of furnishing 52,000 000 gallons a day. At present there are four pumps, one of 10,000,000 and three of 15,000,000 gallons capacity each, making 55,000,000 gallons in all, only 3,000,000 gallons in excess of the pipes, so it is quite probable the other pump will be added this year. The Buffalo Natural-Gas Fuel Company, limited, has been incorporated, and a petition has been presented to the Common Council asking for permission to lay and maintain pipes in the streets.

THE Ohio River Gas Company of Pennsylvania will increase their capital stock this month to $500,000. At the first the intention of the company was to merely limit their transactions to furnishing the smaller towns along the Ohio river above Baden with gas. At their last meeting the directors of the company decided to extend their lines to Alleghany and enter into competition with the companies now operating there. The company has also closed a contract with the National Tube-Works for seven miles of pipe, enough to lay their lines from Baden to Sewickley and furnish their customers in the last-named place. The order is for pipes of eight-inch, six-inch and four-inch diameter, and the first installment is to be delivered this week. Work will be commenced just as soon as the ground is in condition to be dug up. The company has up to this time secured the right of way through the boroughs of Sewickley, Osborne, and East and West Bellevue. Orders for the remaining twelve miles of pipe will be placed at an early day.

HINDS, MOFFETT & Co. have completed the construction of the Newark, O., water works, commenced Oct. 1, 1885. There are 200 hydrants for the use of which the city pays $9,600 per year. The 20 miles of pipe, in size from 16 to 6 inches diameter, were furnished one-half by the Lake Shore Foundry, of Cleveland, and one-half by the Ohio Pipe Company, of Columbus, O. The pumping machinery, which consists of two separate compound, duplex condensing pumping engines, of a capacity to pump 5,000,000 gallons of water in 24 hours, with two boilers of 100 horse power each, were built by the Gordon & Maxwell Company, of Hamilton, Ohio. The boilers were furnished by the Watertown Steam Engine Company, of Watertown, N. Y. The water for supplying the works is obtained by sinking a timber and masonry caisson, 30 feet in diameter, to a depth of 24 feet, at which depth the water rushes in from the gravel strata in great abundance. The reservoir is 262 feet above the city and of 3,000,000 gallons capacity. It was built under the supervision of Wm. Craig, formerly superintendent of construction in the Hamilton, O., water works. The whole work has been in charge of Engineer Henry C. Hodgkins, of the firm of Hinds, Moffett & Co., and Engineer George T. Keith, assisted in the office by Messrs. Chas. B. Stevens and Chas. T. Evans, of Newark, O. Andrew R. Sherman superintended the pipe laying. The works were satisfactorily tested on the 28th ult. Newark now says the regular thing: "that it is proud of the distinction of having the best and most complete system of water works in the State."

NEWS OF THE WEEK.

CONTRACTING.

There is no single class journal in the United States read by so many contractors for all kinds of Civil Engineering construction as ENGINEERING NEWS AND AMERICAN CONTRACT JOURNAL. *We propose as in the past to publish early intelligence of all new contract work. Our prices for advertising proposals for contracts is twenty cents per line, and it is so cheap that parties having any work to advertise will always find it a good investment to use this journal.*

Railroad.—The contractors for the construction of the Chicago & Northwestern R. R. branch from Fremont, Neb., to Lincoln are on the ground making preparations to begin operations as soon as spring opens, and the road will be ready for business early in the coming summer.

Public Buildings.—Council Bluffs, Neb., is to have some important additions in the way of public buildings. The most conspicuous of those at present contemplated are a County Court House to cost $150,000; a Board of Trade building, estimated to cost about $30,000, and a United States Government building, which will approximate a cost of $250,000.

Bridging and Piling.—La Crosse, Wis., February 12.—Superintendent Swineford and Chief Engineer Johnson, of the Chicago & Northwestern R. R., have let the contract to C. C. Smith for piling and bridging on the new line from Winona Junction into the city. There will be 1,300 feet of trestle, about a mile of piling, which will be filled with dirt, and two bridges across the La Crosse river.

Court House and Jail.—S. W. Brooks has been awarded the contract for building the new Court House and Jail at Hidalgo, Texas. The buildings are to cost $20,000, and will be put under construction at once. Bids were received from contractors all over the State.

Starr county is also to build a new Court House at Rio Grande City to cost $25,000.

Pier.—The contract for the new pier at the Sea Breeze, to be constructed by the Rochester end Lake Ontario R. R., has been let to A. S. Laundry, of Charlotte, N. Y. It will be 475 feet long and ten feet wide, except at the extreme end, where, for a distance of eighty feet, it will be eighteen feet wide. It will be five feet six inches above the water. The terms of the contract provide for the completion of the work by April 1st.

Court House.—J. P. Orr, county judge, has been authorized to advertise for plans and specifications for building a brick court-house in the town of Vernon, Texas, the county seat of Wilbarger county, the cost of the court-house not to exceed $35,000. The court will meet the second Monday of April, to adopt plans and specifications, and will not be responsible to architects whose plans and specifications are rejected. The house now occupied as a court-house is hardly worthy the name of a court-house. The new brick jail is about completed.

Contract Awarded.—The contract for an iron, riveted lattice street bridge over the Erie canal at Fultonville, N. Y., was awarded by the Superintendent of Public Works at Albany, February 12, 1886. The bridge is to be 75 feet long, with a roadway 17 feet wide and one sidewalk 5 feet wide, with iron needle beams and floor joints. The bids were as follows:

Sullivan & Ehlers, Albany	$2,611.68
Van Zile, MacCormack & Co., Albany	1,898.00
King Iron Bridge Co., Cleveland	1,885.00
Niagara Bridge Works, Buffalo	1,748.00

Contract let to the Niagara Bridge Works.

Iron Bridge.—Proposals will be received at the Auditor's office, Jefferson county, Indiana, up to 1 o'clock P. M., Thursday, February 25, 1886, for the construction and erection of an iron bridge to span Little Creek, near Kent, Republican Township. Length—175 feet between center of end pins in one span; width of roadway—16 feet and at least 14 feet clear vertical space above the floor; proportioned to sustain a load of one hundred pounds per square foot of floor in addition to the weight of the bridge. Bidders will be required to furnish strain sheets and complete dimension specifications of all parts of the structure, and to accompany their bids with a bond in double the amount of their bid, conditioned according to Section 4246, Revised Statutes of Indiana, 1881. Specifications for said bridge are now on file at the Auditor's office. The Board of Commissioners reserve the right to reject any or all bids. —JAMES H. CROZIER, Auditor, J. C.

Railroad Contract.—P. P. Dickinson, of 7 Nassau St., N. Y., has received the contract for constructing the Atlantic & Northwestern Railroad from Shelby, N. C., to Black's Station.

Omaha & North Platte R. R.—All doubts as to whether the Burlington & Missouri River Railway Company really intends to build the "ox-bow" road from Omaha to the northwest via Ashland, have been put at rest by the filing of articles of incorporation of the Omaha & North Platte Railroad Company. The backers of the new organization are G. W. Holdrege, J. G. Taylor, C. D. Dorman, C. J. Greene and P. S. Eustis, of Omaha, and T. M. Marquett and J. D. Macfarland, of Lincoln. The connection of these gentlemen with the enterprise stamp it beyond question as a Burlington concern, and one that will be well taken care of by the parent company. The route laid down for this road is "from Omaha southwesterly through the counties of Douglas, Sarpy and Saunders, to Ashland; thence northwesterly through the counties of Saunders, Dodge, Butler & Colfax, thence west through Stanton, Platte, Madison, Boone, Antelope, Wheeler, Greeley, Garfield, Valley, Loup, Custer and Blaine counties to a connection with the Grand Island & Wyoming Central Railway, near the northwest corner of Custer county." The intention to build branches to Fremont and Norfolk is also stated. The capital of the company is placed at $5,400,000, of which 10 per cent. must be paid in before active operations are commenced. As the papers on record date from the 14th of October last, it is safe to say the required amount has been subscribed. Omaha *Bee*.

Railroads and Canals.

The Canton and Waynesburg Railroad will extend its line to Waynesburg, O.

New Canadian Connections.—London, Ont., is negotiating with the Canadian Pacific R. R. and the Michigan Central R. R. for connections with that city.

The Chicago, Burlington and Northern R. R. is building a 1,400 foot bridge across the Wisconsin river.

The John Dennis Combination Bridge Co., Chicago, has been incorporated. Capital stock, $500,000. Incorporators, Adolph Ascher, Isaac H. Mayer and William S. Bracket.

The Ohio and Kentucky Bridge Company has filed articles of incorporation at Columbus. Its purpose is to erect a bridge over the Ohio river, between Cincinnati and Covington.

Welland Canal Contracts.—OTTAWA, Feb. 17.—Welland Canal contracts have been awarded as follows: C. F. Dunbar, of Buffalo, four sections; James Ichester, of Ottawa, three sections; F. B. McNamee, of Montreal, and John Conlan, of Thorold, one section, and R. T. Sutton, of Toronto, one section. The aggregate price for the entire work is about $400,000.

Panama Canal.—PANAMA, Feb. 17.—Ferdinand de Lesseps and the European delegation appointed at his invitation to inspect the Panama Canal arrived in Colon to-day on the steamer Medway. They will arrive in Panama on Sunday next, making an inspection of the canal works en route in the meantime.

Utah Central R. R.—The building of a branch of the Utah Central through the mountains into Central California and San Francisco is said to be entirely feasible by the Union Pacific's engineers, who have been looking over the ground.

Wooden Bridges.—The Archuleta, Col., County Commissioners will build a wooden two-span bridge across the San Juan river at Pagosa Springs, and similar structures across the Predia and Navajo rivers.

Montana Central Work.—"A third surveying party of 15 men with B. P. Tilden, C. E., at the head, left Helena to-day to prosecute surveys for the Montana Central R. R. beyond Wolf Creek.

The company's locating surveys now cover a distance of 50 odd miles, and grading contracts have been let for upwards of 30 miles. Rock blasting and brush cutting are in progress in Prickley Pear Canon and other indications of active operations are multiplying every day."

The Southern Pacific R. R., Cal., is contemplating the construction of a cut-off from Lancaster to Colton Cal., to be used for through Southern business and which, it is thought, will be a great saving to the company during the high-water season.

Another Brooklyn Elevated Railway.—A new line is proposed which will extend from the East river to Coney Island and various points. The supposition is that the new road will connect with the old Gunther road, which was recently purchased by E. B. Litchfield.

Another Great Ship Canal Projected.—The Mayor of Birmingham (England) has called a meeting of the merchants and manufacturers to consider a scheme to connect that city with the river Severn by means of a ship canal.

A New York Line.—Surveyors have begun staking out the proposed route of the railroad from Canastota to Camden. It is thought grading will begin early in the spring.

The Dubuque (Iowa) Union Depot Company, of that city, has bought of the Illinois Central Railroad Company the block of ground on which the company's freight depot now stands for $100,000, on which will be erected, this summer, an elegant Union passenger depot.

Kansas City, Birmingham & Memphis R. R.—The Mississippi House of Assembly has approved the bill incorporating this road. The bill provides that the Memphis, Birmingham and Atlantic Road can not approach nearer than twelve miles to the first-named road.

A Minnesota and Northwestern R. R. Move.—President Stickney of the Minnesota and Northwestern R. R. has organized a company, mostly of Chicago capitalists, for the purpose of building a new and independent line from Chicago to Dubuque.

The Muskegon, Grand Rapids & Indiana R. R has been incorporated to build a road from Grand Rapids to Muskegon. The Directors and Incorporators are: W. O. Hughart, W. R. Shelby J. M. Metheany, J. H. P. Hughart, T. J. O'Brien, Grand Rapids; N. L. Keating, N. McGrath, Muskegon. The capital is $250,000

Pittsburg Elevated R. R.—HARRISBURG, Feb. 16.—At the State Department to-day an application was made for a charter to the Pittsburg Elevated Railroad Company, with a capital of $50,000. The application has been referred to the Attorney General to decide whether the State had the power to incorporate an elevated road.

Nashville & Chattanooga R. R. Branch.—A railroad is proposed from Elira to Huntsville, Tenn., a branch of the Nashville & Chattanooga Railroad. The distance is twenty-six miles, and a survey made by Mr. Hunter McDonald put the cost at not over $250,000.

The Stevens Point, Wausau and Northern Railway Company has filed articles of association at Madison, Wis., the incorporators being J. B. Canterbury, G. C. Hixon, J. T. Pettingill, W. W. Cargill and B. E. Edwards, all of La Crosse. The company has a capital stock of $800,000, and will build a line from Stevens Point northward to a point on the Michigan State line, in Forest county, a distance of 150 miles.

A New Bridge.—A bill is to be introduced into the Legislature, providing for a bridge over Newtown creek at Maspeth avenue (Brooklyn) to cost $25,000, and Kings county and Newtown to bear the expense equally. This is an old measure which the Queens County Board of Supervisors refused to sanction.

A Texas and Mexico Short-cut.—EAGLE PASS, February 11.—A corps of engineers, under Major Killebrew, of Nashville, Tenn., have gone to Monclova, in the interest of the proposed extension of the F. C. I. M. R. R. from that point. Should this extension be made to the Mexican Central Railroad the distance to the City of Mexico by rail from the principal cities of the United States would be shortened 500 miles.

The Chicago and Northwestern R. R. will put a force in the field as soon as the weather will permit, to locate a branch line running south from its present Wyoming extension to the neighborhood of Fort Fetterman, and possibly to Cheyenne, it being the intention of the company to furnish the necessary railroad facilities for the country lying between the legitimate territory of the Union and Northern Pacific roads.

The Bay City, Caro & Port Huron R. R. Co. has been incorporated in Michigan. Capital stock, $1,000,000 President, Wm. Westover, Bay City; Vice President, Henry Howard, Port Huron; Secretary, H. P. Merrill, Bay City; Treasurer, Charles Montague, Caro. An executive committee consisting of W. H. Tousey, of Bay City, Wm. Hartsuff, of Port Huron, and John F. Wilmot, of Wilmington, was elected and instructed to engage at once on a survey of route.

The Winona, Alma and Northern R. R. some years ago got the right from Congress to build a bridge over the St. Croix, between Hudson and the Mississippi. Now the Secretary of War, although he has approved the plans and specifications, says the assignment of the franchise of the road to the Burlington & Northern R. R. cannot be recognized. Senator Spooner has introduced a bill giving the new road the right to build the bridge.

Texas Railroads.—Major Marvin, Chief of the Surveying Corps of the Gulf, Colorado and Santa Fe R. R. is running a line from Dallas to Red River via Paris. The points to be touched on the survey include Dallas and Paris, the only other points bidding for the road not having closed contracts. The Missouri Pacific R. R. surveying party is moving south from the East Line R. R.

The Schuylkill Valley's Deep Cut.—Contractor McFadden has commenced working night and day at the deep cut north of Harrisburg. Two steam shovels are working towards each other, and three locomotives and a steam derrick are employed in removing the loaded cars from the cut. The cut is 70 feet deep and is the most stupendous work along the entire line of the Pennsylvania Schuylkill Valley Railroad. It is estimated that nearly three months will be required to complete the roadbed for the rails.

The Montague and Southwestern Railway (Texas) is pushing rapidly. It will intercept the Fort Worth and Denver R. R., near Brushy Mound, at a point twelve miles from Montague. The grading from Montague to a point seven and a half miles westward is nearly completed. About a hundred teams are at work, and the grading will be finished through to the Fort Worth and Denver line within sixty days.

Harlem River Bridge.—The Commissioners of the new Harlem River Bridge have concluded to have the structure built in accordance with the plans of C. C. Schneider, who, in a competitive trial, was awarded a prize of $1,500 for furnishing the best plans.

Quick Work.—"Ties are being delivered along the line of the Helena and Rimini branch of the Manitoba Central R. R. Grading contracts have been let to cover the entire distance between this city and Red Mountain."

A Wisconsin Railroad.—Work will be commenced at once on the preliminary survey of the new railroad to run from Hurley to the mouth of the Montreal river, Wis.

The Fort Smith and Southern Railway Company has been incorporated in Arkansas. Capital, $2,500,000. The road is to run southward from Fort Smith in the western tier of counties in Arkansas to Red River, 150 miles. The Board of Directors consists of Jno. O'Day, Jas. Dun, D. H. Nichols, A. Douglas, Jesse Turner, Charles Hall, James Brizzolani, B. Baer and W. M. Fishback. The first three named are the Attorney, Assistant General Manager and Chief Engineer and Traffic Manager of the St. Louis and San Francisco Railroad.

The Canadian Pacific R. R. will be extended by a Western syndicate from Algoma Mills to Sault Ste. Marie, whence a direct line to Minneapolis is building. The activity of the Canadian Pacific R. R. in surveying branches south of its line has evidently had its effects upon the owners of the Northern Pacific R. R., and it is stated that other work than that of the Cascade Division will be undertaken during the present season. Among the branches to receive the first attention are Gault Mountain, Phillipsburg, Tongue River and the Red Mountain or Ten Mile Creek, all of them short, but prospectively paying lines.

Sioux City and Des Moines R. R.—Sioux City Iowa, has just voted a tax of 5% in favor of the Sioux City and Des Moines R. R., the vote standing 1158 for and 371 against. This road will be built and managed by Sioux City capitalists in the interests of and for Sioux City. The tax will amount to about $160,000.

The Board of Directors are; John Pierce, D. F. Hedges, W. E. Johns, James E. Booge, Ed. Hackinson, T. P. Gere, F. C. Hills, C. Shenkburg, C. F. Hoyt, John Hornick; the Officers are: President, John Peirce; Vice-President, T. P. Gere; Treasurer, A. S. Garretson; Secretary, F. C. Hills; Engineer, L. F. Wakefield.

An Obstructing Bridge.—Capt. Lockwood, Corps of Engineers, has reported to the Secretary of War that the railway bridge across the St. Joseph river near the town of St. Joseph, Mich., is an obstruction to free and safe navigation. He recommends that the present south draw be replaced with a pivot draw having clear openings on each side of the pier of 100 feet. "Should the bridge be modified and the south dock line advanced, then the needed improvements at this harbor could be carried to completion, and there would then exist a condition of affairs that would give this harbor something like its former value and importance as a harbor of refuge."

Belle Isle Bridge Specifications.—The specifications for the Belle Isle, Mich., Bridge provide that it shall be 2,017 feet long from pier to pier. The roadway of the bridge is forty feet wide, giving two twenty-foot driveways and walks eight feet wide on either side. The bridge is to be twenty feet above the average level of the water. It will have a draw span 307 feet long, leaving a clear passage when open of 130 feet on each side. The draw-bridge will be operated by an engine and will swing in two minutes and a half. It will have two abutments, eleven channel piers and one pivot pier. Length of each span as follows: Two fixed spans (each 153), 306 feet; nine fixed spans (each 156), 1,404 feet; one draw span, 307 feet. Total—2,017 feet. The cost of the bridge is approximated at $300,000.

Canada's Railway Mileage.—Appended is a statement of the railway mileage of Canada in operation January 1, 1886, nearly all the lines are standard gauge:

	MILES.
Albert Railway, N. B.	45
Bay of Quinte Railway Navigation Company	15
Canada Atlantic Railway	135
Canadian Pacific Railway	3,678
Carillon and Grenville	14
Central Ontario	104
Chatham Railway, N. B.	9
Coburg, Peteboro and Marmora Railway	15
Cumberland Railway, N. S.	32
Eastern Extension Railway	80
Elgin, Petitcodiac and Havelock Railway, N. B.	14
Erie and Huron Railway	36
Grand Southern Railway, N. B.	82
Grand Trunk Railway	2,693
Intercolonial Railway	830
International Railway Quebec	69
Kingston and Pembroke Railway	61
Manitoba and Northwestern Railway	130
Michigan Central, Canada Southern Division	376
Napanee, Tamworth and Quebec	28
New Brunswick Railway	307
Northern and Northwestern Railway	382
Prince Edward Island Railway	196
Quebec and Lake St. John Railway	44
Quebec Central Railway	148
St. Martins and Upham, N. B.	30
Southeastern	135
Western Counties Railway, N. B.	67
Windsor and Annapolis Railway	130
Total	10,027

There is also a considerable mileage of track which will be open for traffic soon, and by July 1 Canada will likely possess 11,000 miles of railway.

Market Report of Engineering Materials.

New York, February 18, 1886.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.	
Angles	1.95c @ 2.00c
" steel	2.35 @ 2.45
Tees	2.25 @ 2.35
Beams and channels, American	3.0 @
Tank	1.95 @ 2.1
Shell	2.4 @ 2.5
Steel plates, Tank	2.5 @
WROUGHT-IRON PIPE.. PITTSBURGH.	
Butt welded, black.....Discount	42½ @ 45
" " galvanized..... "	32½ @ 35
Lap welded black..... "	60 @ 62½
" galvanized..... "	42½ @ 45
Boiler tubes..... "	55
RAILS.	
Steel (large lots at mill)	$34.00
Old rails	21.50 @ 22.25
Old rails, steel	22.00 @ 23.00
R R. spikes	2.40c.
R R. splice-plates	2.00
R R. track bolts, square nuts	3.00
Barb-wire fencing, galvanized	5.00
" painted	4.00
Corrugated iron	
Nails	
Iron, per keg	2.40 @ 2.50
Steel do.	2.60 @ 27.5

METALS.

COPPER.	
Lake Superior	$11.35 @ 11.60
Other Brands	10.25 @ 10.45
LEAD.	
Com. Domestic	4.65 4.70
Lead Pipe	.06¼c.
Tin-Lined Lead Pipe	.15
Sheet Lead	.07¼
ZINC.	
Sheet	$5.10 @ 5.20

BRICK.

Cargoes (afloat)	
Haverstraw.....per M.	$9.00
Fishkill	
Up-River	
Jerseys	
Long Island	8.50
" Pale	4.00
FRONTS.	
Croton, red	11.00 @ 14.00
" dark	11.00 @ 14.00
" brown	10.00 @ 13.00
Philadelphia pressed	24.00 @ 25.00
Trenton "	24.00 @ 25.00
Baltimore "	37.00 @ 41.00
Buff "	33.00 @ 35.00
Enameled English	65.00 @ 130.00
" American	85.00 @ 120.00
Fire brick	24.50 @ 55.00

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

Alsen's Portland Cement Works	$2.50 @ $3.00
BAETJER & MEYERSTEIN:	
Hanover Portland	2.60 @ 2.65
BELLONI & Co.:	
Hemmoor "Crown" brand	2.50
JAMES BRAND:	
R. B. & S	2.55 @ 3.00
BROOKS, SHOOBRIDGE & Co.	2.45 @ 2.60
HOWARD FLEMING:	
Gibbs' English Portland, 400 lbs	2.65 @ 2.90
" R. B. & S. "	2.75 @ 2.95
Stettiner, German	2.65 @ 2.85
Lagerdorfer, "	2.45 @ 2.75
Fiove, A 1, Belgian	2.35 @ 2.50
Roman	2.75 @ 3.00
Keene's Coarse	4.75 @ 5.50
" Fine	7.75 @ 8.50
" Superfine	8.50 @ 10.00
FISHER, ERSKINE W.:	
Stettin (German) Portland Cement	$2.40 @ 2.75
GABRIEL & SCHALL:	
Vorwohler "Lion"	2.65 @ 3.10
HUDSON RIVER CEMENT CO. Rosendale	1. 0
JOHNSON & WILSON:	
Saylor's American Portland	2.15 @ 2.40
LESLEY & TRINKLE, Philadelphia, Pa.:	
"Giant" Portland	2.20 @ 2.40
Improved "Union"	1.25 @ 1.50
Union	1.10 @ 1.20
MARCIAL & Co.:	
J. B. White & Bros. Coarse	4.50 @ 5.00
" Fine	8.00 @ 10.00
" Portland	2.45 @ 2.85
NEW YORK CEMENT CO.:	
Rosendale	1.20
N. Y. & ROSENDALE CEMENT CO.:	
Rosendale, "Bridge" brand	1.10
SINCLAIR & BABSON:	
R. B. & S	2.35 @ 2.60
STANDARD CEMENT CO.	
E. THIELE:	
Dyckerhoff	2.90 @ 3.25
UNITED STATES CEMENT CO.:	
Windsor	1.00 @ 1.10
Standard	1,15
Coplay Portland	2.15 @ 2.40
UNION AKRON CEMENT CO.:	
Akron "Star" brand.	

ASPHALT.

Prices range per ton	$15.00 @ 20.00
According to quantity or brand, and whether taken from vessel or store.	

LIME.

Rockland, common per bbl	1.00
" finishing	1.20
State, common	.90
" finishing	1.10
Kingston, ground	95 @ 1.00
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95 @ 1.00
" " No. 2 "	0.75 @ 0.85
" " light drab "	0.80 @ 0.95
Berlin " in rough "	0.75 @ 1.00
Berea " " "	
Brown stone, Portland, Ct. "	1.00 @ 1.35
" Belleville, N. J. "	1.00 @ 1.35
Granite, rough	0.45 @ 1.25
Common building stone per load	2.00 @ 3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @ 3.00

SLATE.

Purple roofing per square	6.00 @ 7.00
Green "	6.00 @ 7.00
Red "	15.00
Black Penna. (at New York) "	4.50 @ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00 @ 20.00
" Choice "	65.00 @ 70.00
Tally plank, 1¼ in. 10 in. dres'd. each.	.44 @ .50
Tally boards, dressed com. "	.28 @ .30
SPRUCE, Boards dressed "	.25 @ .28
Plank, 1¼ in "	.28 @ .30
" 2 in. "	.38 @ .40
" 2 in. dressed "	.43 @ .45
Timber per M.	20.00 @ 22.00
HEMLOCK, Boards each.	.18 @ .20
Joist, 2½ × 4 to 4 × 6 in	.16 @ .44
OAK per M.	55.00 @ 65.00
CYPRESS 1, 1¼, 2 and 2¼ in "	35.00 @ 40.00
YELLOW PINE, Girders "	25.00 @ 30.00
Dressed flooring "	28.00 @ 35.00
SHINGLES, Extra shaved pine, 16in. "	
" sawed 18 in. "	5.75 @ 6.00
LATH, Cargo rate "	2.30 @ 2.35

PAINT.

Lead, white, American dry per lb	.04½ @ .06
" " in oil pure "	.06½
" English, B. B. in oil "	.08¾ @ .08¾
" Red, American "	.05¼ @ .05½
Litharge "	.05 @ 05½
Venetian red, American "	.01 @ .01¼
Indian red "	.05 @ .10
Vermillion, American lead "	.10½ @ .12½
Paris green "	.15 @ .20
Umber, Amer. raw and powdered per lb.	.01¼@ .01¾
Drop black, Amer. "	.07 @ .13
" " Eng. "	.11 @ .13
Chrome green "	.05 @ 20
Oxide zinc, American "	.03¾ @ .04
" French "	.06 @ .08

Trade Notes.

THE Cambria Iron Co., at Johnstown, Pa., has received an order from the Chicago, Burlington and Quincy Railroad for 1,500 tons of steel rails; and the Pennsylvania Steel Company has booked an order for 10,000 tons for the same road.

THE Marshall (Tex.) Foundry and Wheel Factory have closed a contract with the receivers of the Texas & Pacific Railroad Company to supply the road and its branches with car wheels and all its castings.

THE St. Louis architectural iron works have about exhausted their old, and have very few new, contracts. There are at present only two or three large contracts not worked out.

THE New York Locomotive Works, Rome, are now engaged upon three 10-wheel freight engines for the Rome, Watertown and Ogdensburg R. R.

THE Brooks Locomotive Works, in Dunkirk, N. Y., have taken an order for three locomotives for the new Chautauqua Lake R. R., to be delivered early in the spring; and has received a large order from the Union Pacific R. R.

THE Akron Sewer Pipe Agency of Akron, O., was dissolved recently, and in its place was organized the American Sewer Pipe Co., which will take all the product of the mills, formerly in the agency.

THE President and Directors of the Sheffield Land Co., at a meeting in Montgomery, Ala., arranged to have an iron furnace of the capacity of 150 tons built at Sheffield.

THE Columbia Iron Company, with a capital stock of $50,000, has been chartered at the Pennsylvania State Department. Work has been commenced on the new mill site. The contract calls for the mill's completion in thirty days.

THE Knoxville Car Wheel and Machine Company has received an order from the Savannah, Florida and Western Railroad for 4,200 wheels on axles to be delivered the first of May, when they change to standard gauge. The machine department of these works is so crowded that they will be compelled to run night and day for the next four months.

OTTAWA, Feb. 9.—The prospects for this year's lumber trade in the Ottawa district are reported better than for many years past. The cut this year will be unusually large, the output being estimated at 600,000,000 feet. Sales have already been made to the value of $4,500 000, and the prices obtained are better than previously recorded.

BUFFALO, N. Y., Feb. 9.—The plans for the enlargement of the West Shore shops at East Buffalo to suit the requirements of the New York Central Sleeping Car Company have been received here. The shops will be enlarged so that 30 cars can be handled at one time. The changes are estimated to cost $200,000. All of the cars of the company will be built here, as well as the making of all repairs. It is expected that 600 men will be kept busy when the shops are finished.

NEW YORK, February 6.—A Montreal special says: It is learned that Canadian buyers have taken heavy deals in the Glasgow pig iron market, attracted there by the unusually low prices. Over 50,000 tons have been bought by strong parties who believe prices cannot go lower. The purchase was made at about 40s, and after it was closed prices ran up to 40s 2d. A large dealer here says there are many Montrealers as well as Western foundry men in the deal, and that a combination is being formed to "bull" the market.

PHILADELPHIA, PA., Feb. 7.—There are orders with the different steel rail manufacturers of the country estimated at 60,000 tons. The number would in all probability be 120,000 tons, if the manufacturers were disposed to accept payment for their product in bonds and stock of projected lines. As this class of security is in the hands of financial agents in the leading business centers, they will undoubtedly be placed, and the orders for steel rails will eventually be placed for cash to a better advantage, both to purchaser and manufacturer. The Bessemer manufacturers, at a meeting just held here, have decided not to increase the output from 1,000,000 tons to some higher figure, but to meet again and consider the subject when the requirements of the market make it necessary.

IN the case of the Chicago Tire and Spring Works against the Collector of Customs at Chicago the Supreme Court has decided that the Inspector of Customs had properly classified steel tire blooms under Schedule E, Section 2,504, which requires a duty of 45 per centum ad valorem on all manufactures of steel or of which steel is a component part, and on all articles of steel partially manufactured. The plaintiffs insisted that they should have been classed under another paragraph as "steel in any form not otherwise provided for, 30 per centum ad valorem."

THE annual exports from Queensland are now about $18 000,000, mostly wool, preserved meats and tallow; South Australia, $27,000,000, mostly wool, wheat, flour and copper; Tasmania, $4,000 000 mostly wool, grain and fruits; Victoria, $80,000,000, mostly wool, grain, gold and flour; West Australia, $3,000,000, almost entirely wool and lead ore. In the five provinces there are 4,312 miles of railroads and 17,743 miles of telegraph lines. Instead of the short lines along the coast, the railroads now cover long distances, as the great areas are being opened up. Western Australia alone is 1,280 miles long and 800 miles wide, but the inhabited part of the province is only 600 by 150 miles in length and breadth.

THE copper production for the last decade is as follows in long tons:

Years.	Long tons.	Years.	Long tons.
1876	19,000	1881	33,000
1877	21,000	1882	40,967
1878	21,500	1883	51,574
1879	23,000	1884	63,555
1880	27,000	1885	70,109

Of the 70,109 tons produced last year, the Lake Superior region is credited with 31,763; Montana, 26,660; Arizona, 10,268; other states and territories, 1,518. The exports were 34,375 tons; consumption 42,165; stocks December 31st, 4,464.

A GENERAL survey of our foreign markets reveals some points of interest. Chili gives signs of improvement. In Peru there is restored confidence. In the Argentine Confederation trade is dormant, and in consequence of a deranged currency is the worst known for years. English and German houses suffer in common with all others. Australia is slowly recovering from bad seasons experienced by agriculturists, low prices for sugar, etc. New Zealand remains depressed. Throughout the East, in China, Japan and Oceanics, in the Dutch and British East Indies, the depression is extraordinary, and there are no signs of recovery. Among European countries the situation in France is perhaps the most discouraging.

THERE is considerable difference between the workmen and operators as to the cost of coke. The former claim that it costs but about $1 a ton to put coke on the cars; the operators that $1.15 is nearer the mark. The following are for actual workings for the month of November.

	No. 1.	No. 2.
Average cost of coal to ton of coke, including royalty	76.7	81.8
Average labor at ovens	27.0	22.3
Average supplies	7.3	7.0
Average repairs	6.2	2.9
	117.2	124.5

The above are actual costs, not estimates, and may be taken to fairly represent the average, not the best located works. The items of repairs may vary somewhat, as well as the cost of coal, but the No. 1 is a fair cost, including royalty. The miners' figures of cost are as follows. They represent the daily expenses of a bank of 40 ovens, 20 being drawn each day:

Cost of coal (on royalty ½c per bushel)	$12.35
70 cars of coal (mining 27c a car)	18.90
Boss' wages	2.00
Oil, posts, rails, etc	1.50
Charging ovens	2.00
Leveling	1.00
Drawing 20 ovens	11.00
Interest on capital	2.50
Syndicate's commission	3.05
	$53.15
Production 58 8-10 tons coke, at $1.20	$70.95
Less daily expense	53.15
	$13.41